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A Gorilla Named Joe 76

With *Mighty Joe Young*, director Ron Underwood put a modern spin on the venerable film classic about a lovable giant gorilla plucked from his idyllic home in Africa and given a dose of big-city life. While the original Joe was a triumph of stop-motion animation that astounded moviegoers of its time, the updated ape would be no less remarkable, brought into being through sophisticated animatronics and suit artistry by Rick Baker, in concert with groundbreaking visual effects spearheaded by Hoyt Yeatman of Dream Quest Images. *Article by Scott Essman.*

The Sweet Hereafter 110

A metaphysical speculation on the nature of the afterlife, *What Dreams May Come*, based on a novel by Richard Matheson, chronicles the spiritual journey through Heaven and Hell of a man determined to reunite his family and rescue his soul mate from an eternity of suffering. Guided by director Vincent Ward, whose singular vision of the hereafter infused the project, visual effects contributors Mass.Illusions, POP Film and Digital Domain offered up dazzling technical innovations in the service of an extraordinary aesthetic concept. *Article by Kevin H. Martin.*

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COVER – Jill Young comforts her gargantuan friend in *Mighty Joe Young*.

PLEASANTVILLE
COLOR MY WORLD

article by Matthew J. Macdonald

Ever since color came to motion pictures, filmmakers have, for the most part, eschewed the monochromatic form, turning to black-and-white only when it served a dramatic or thematic purpose. In The Purple Rose of Cairo, for example, Woody Allen had a classic matinee screen hero leap out of the black-and-white world he inhabits and become colorized upon entering the real world. In Schindler's List, Steven Spielberg underscored the bleakness and despair of the holocaust by shooting in black-and-white, using color to draw the viewer's focus to the pivotal image of a red-coated little girl moving within the colorless setting, then ending the monochromatic film with a modern-day coda illuminated in full-color sunlight.

The contrast of black-and-white against color again provides a thematic metaphor in Gary Ross' Pleasantville– but more ambitiously than ever before. A writer of considerable acclaim, Ross had penned screenplays for Big and Dave, both of which reflected a sense of wonderment that is also at the core of Pleasantville. His inaugural foray into feature film direction, Pleasantville is the tale of two adolescent siblings– David (Tobey Maguire) and Jennifer (Reese Witherspoon)– who, via a series of inexplicable circumstances, become trapped in Pleasantville, a classic black-and-white television show reminiscent of Leave It to Beaver and Father Knows Best. David is an aficionado of the sitcom, and eagerly anticipates the marathon of episodes slated to begin one evening; but his sister has other plans for the family television. In the course of a heated argument, the siblings manage to shatter the remote control, rendering the television inoperable. Before anyone even thinks to make a service call, a mysterious TV repairman (Don Knotts) shows up at the door with a strange metallic replacement for the demolished clicker. Once again, the brother and sister wrestle for the remote; but as they do so, they are literally sucked into the monochromatic world of Pleasantville, USA.

The teenagers' impact on that black-and-white world is manifested in vibrant colors that begin to appear on foliage, cars, buildings and the citizens of Pleasantville themselves. "Although seemingly perfect," noted Ross, "Pleasantville is a black-and-white town that is devoid of the extremes that make life interesting. As a result of these two kids being transported there, various characters are 'born' into color through experiences of trauma and upheaval brought on by the freedom of thought. At the other end of that transition, they find satisfaction and the rich contrast of being alive."

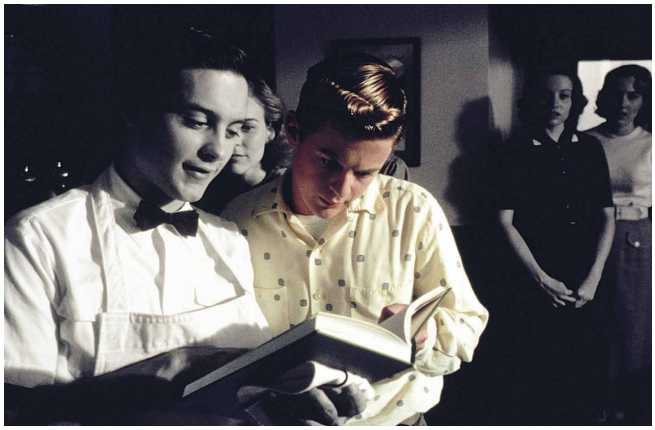
Ross' allegory of vivid color consciously seep-ing into a colorless world necessitated nearly two years of concentrated visual effects development and implementation. The production's final slate of almost seventeen hundred visual effects shots comprised one hundred minutes of screen time, more than any motion picture in history. "I realized early on that this film was going to be the first huge special effects movie that wasn't about monsters or blowing things up," reflected Ross. "It's about subtlety. The nice thing about these effects– and probably the biggest difference between them and most other visual effects– is that you are supposed to

notice them. Every character in the movie knows when something turns to color– they take note of it and talk about it. I wrote it that way to ensure the audience would know that the colorization wasn't a filmmaking trick or a perceptual way of telling the story, but something that had actually happened in that world."

From the beginning, Ross recognized that the premise was risky, not only technologically, but in terms of its impact on an audience. "The question that really scared me going in was, 'What would the human eye do to an image that was half black-and-white and half color?'" Ross recollected. "I'd seen it done in advertising, but never in a traditional narrative. I wondered if the eye would go right for the color and if that would keep the audience from being able to follow the story in a linear fashion. Would they be able to shift focus to the black-and-white character in a two-shot, for example, and then shift back to the character who was in color? That was my biggest anxiety."

In the Gary Ross film, Pleasantville, David (Tobey Maguire) and Jennifer (Reese Witherspoon), two modern-day teens zapped into a fifties television sitcom world, gradually introduce color– both literally and figuratively– into their black-and-white surroundings.

An effects approach for colorizing objects in a black-and-white environment had not yet been worked out when New Line Cinema gave the project its greenlight. Knowing that his story would require a solid command of various visual effects issues and a copious postproduction effort, Ross selected as visual effects supervisor Chris Watts, who had worked with effects supervisor Micheal McAlister on Waterworld and The Hudsucker Proxy, and had supervised the effects for Gattaca. "As I read the script for Pleasantville," Watts commented, "I realized how difficult this movie was going to be. Just in terms of sheer volume, it was going to be the biggest visual effects movie ever made. I couldn't resist the challenge."



The visual effects– supervised by Chris Watts, with color design by Michael Southard– entailed conversion of color production photography to black-and-white and then selective reintroduction of color elements. Editel Hollywood, Computer Film Company and Cinesite contributed.

The movie also required someone on the cut- ting edge of film colorization. To serve as his color effects designer, Ross engaged Michael Southard, a fine artist and painter who had co-developed a colorizing software so advanced that vintage black-and-white films treated with the tool could hardly be distinguished from those actually shot in color. "Michael has a tremendous sensitivity to color," Ross affirmed, "and a highly refined eye, which was exactly what I needed for this movie."

Together, Southard and Watts assembled an effects contingent that came to be known as Pleasantville Visual Effects. PVE, in turn, would be supported by a triumvirate of outside vendors– Editel Hollywood, Cinesite and Computer Film Company– which would contribute everything from scanning and recording to compositing and color timing. In fact, Chris Watts approached CFC eight months before assembling PVE to enlist the company's aid in preparing preliminary tests and formulating an approach for revolutionizing color correction technology. "When Chris was setting the whole thing up," recalled CFC producer Janet Yale, "he came to us to establish how such an enormous enterprise could be done. He needed to explore all of the possible methodologies. In a couple of two- or three-day sessions with Chris and Gary Ross, we used a Cineon to go through the variations of how colorization could be handled, running a multitude of tests to determine whether it would be possible to pull mattes at a lower resolution– in order to expedite the process– and then scan the data up to a higher resolution."

Long before cameras rolled, the decision was made to shoot the entire movie in color, then use digital effects wizardry to create all things monochrome. The reasoning was that shooting in color would afford the visual effects team greater control in the creation of black-and-white imagery, resulting in a more consistent look. For specific color effects sequences, the original color stock would be retained. "The decision to film entirely in color, including the completely black-and-white scenes, was made because we didn't know what to expect going into any particular shot," recounted Michael Southard. "For some shots we would use the original color from the film stock; for others we would completely create the color effects."

The commitment to transforming color footage to black-and-white throughout much of the movie, however, sentenced Watts and his visual effects team to an enormous, unprecedented task. "Everything needed to be scanned and manipulated in some way," Watts remarked. "There was no debate about whether or not something was to be scanned– it all had to be because we'd committed to making every shot in the central Pleasantville portion of the movie a digital effects shot."

Granted just a little more than a year in which to complete all of the postproduction work, Watts sought expedient measures for creating the effects footage, including a new scanning procedure. "In order to scan as many frames as we had in a somewhat short amount of time," Watts explained, "I was forced to find a new kind of process for transferring the film to a manageable data-based form faster than it had ever been done before. I'd heard about a joint project between Kodak and Philips that had been developed in Europe, known as the Spirit Datacine. It was essentially a telecine– a machine generally used to transfer film to video. The difference is that the Spirit transfers film to 2K digital files, color corrects them on the fly, and then lays them off to tape at a speed of four frames per second– as opposed to the average scanner, which processes one frame every ten to thirty seconds." The Datacine promptly became the show's official film recorder, utilized to create digital files for on-station animation. "We also adapted our Spirit to scan in full 10-bit Cineon color space, which none of its counterparts is capable of. Other adjustments allowed us to see the film images on a monitor as they would appear in the final edit and make interactive color corrections before outputting them through the Lightning recorder."

Tasked with harnessing the Spirit's tremendous power was Cinesite, the dual facility called into service by Watts to provide support on two fronts. Cinesite Digital Imaging took care of data transfer– which included scanning and recording– while Cinesite Digital Studios handled basic rotoscoping and painting tasks. "Chris Watts offered himself up as the guinea pig for us to get the Spirit on-line," remarked Cinesite digital imaging supervisor Bob Fernley. "He needed to get his film frames into data form as quickly as possible. And it was critical to get the data in and out at a steady rate concurrent with Pleasantville Visual Effects' needs. Using machines like the Lightning or Solitaire, we'd have been looking at a postproduction time of months and months. With the Spirit, however, both recording and processing took only twenty-two weeks to complete. In the end, a total of 3.2 terabytes was processed, scanned and recorded– which is substantially more than any other film has done."

David applies black-and-white makeup to his sitcom mom, Betty (Joan Allen), who is initially ashamed of her new colored status.

Betty blooms under the loving attention of soda shop owner and budding artist Bill Johnson (Jeff Daniels).

Once the film stock was translated into digital files at Cinesite, it was delivered to PVE for manipulation. "We used a combination of programs to assemble our color-correction arsenal," said Watts, "including Avid's Media Illusion, Matador, Shake and Commotion, along with a huge amount of customized software created by our chief scientist and software developer Raymond Yeung." The process of making the full-color footage monochrome was a straightforward task, with digital artists simply removing color information from on-station data. "Because these shots had been 'pre-timed' on the Spirit, we were generally able to use a standardized monochrome formula to arrive at the black-and-white we wanted. For many monochrome shots, it was simply a matter of verifying that our initial timing looked correct when the shots were cut into the movie."

Specific color effects were then added to the black-and-white footage, as dictated by the story. Many variables had to be taken into consideration as color imagery was digitally merged with the monochromatic environment. "There were issues of how much saturation could occur– how much the frame could tolerate," stated Gary Ross. "Also there were issues of perceived saturation versus

actual saturation. We discovered that eighty percent saturation appears to be one hundred percent saturation when placed in a black-and-white environment, where light sources are obviously cooler. So the highlights on a character in that environment would be less saturated because they would be reflecting a black-and-white light source."

Pleasantville's first-ever rainstorm produces a vibrantly hued rainbow– a digital matte painting executed by Mark Sullivan of Compound Eye.

The invasion of color in the monochromatic world begins subtly with a blooming red rose, then rapidly spreads. As sex, free thinking, literature, art and new kinds of music pervade the town, the citizens of Pleasantville themselves become full color, setting off citywide controversy. Editel Hollywood was particularly instrumental in the development of the color effects, creating a video version of the entire movie at low resolution so that such effects could be planned out in advance. "We did a telecine transfer of all the dailies," said Editel digital compositor Mark Robben, "so that the editorial process could commence while Chris and his team utilized the video version of the film as a template for their effects. Such a method was beneficial in allowing the director and effects technicians to achieve an instant turnaround and preview selected colorization shots before attempting them on-station. Quantel's Henry was used because it was capable of creating images that were virtually identical to what the final film output would be."

Using the video-resolution images as reference, a staff of ten animators at PVE created what were essentially holdout mattes to restore color only to specific features within a scene. Using customized software, Southard, Watts and digital color artists pulled various layers of mattes within a given shot, consequently isolating each element for digital colorization. Those mattes consisted of hundreds, even thousands, of tiny polygons that were reshaped slightly for each frame of film, following the isolated objects as a scene progressed. "We couldn't just 'cut out' the colorized objects," said Southard, "because they would tend to look flat. To create a more three-dimensional look, we used small on-screen outlines to isolate the subject and create an overlaying transparency, which allowed us to massage a color, pull highlights up or down, saturate certain areas, or desaturate those same areas. That approach ended up working out better than any of us had expected."

The color work went way beyond simply restoring the original color footage to specific objects, however. Because color was so vital to both the visual style and the content of the film, each effect was essentially a work of art, carefully developed and meticulously applied under Michael Southard's supervision. "In the same way that the director of photography is the master of light and shadow," noted Watts, "Michael was our 'architect of color.' He used our software and his own artistic sensibilities to define the look of all the colors in the film. He used hue and saturation and value and every other quality of the color spectrum to determine the mood of each individual scene. It was important, because the appearance of color is what drives the story and the characters in this movie."

Nothing disrupts the even pleasantness of the town more than the emergence of color among its citizens. Although sometimes adjusted in intensity, flesh tones remained in the finished film just as they had appeared on the original color stock. "As much as technology and CGI have evolved," noted Southard, "a skin tone is a skin tone, and there's nothing like it. Therefore,

most of the flesh tones in the film were original." Conversely, most of the hair colors were created, due to the fact that when the contrast of the surrounding black-and-white world was added to the original color photography, the hair took on inappropriately red tones.

The 'anti-colored-people' sentiments of some of the town's inhabitants are poignantly illustrated in a scene in which sitcom mom Betty (Joan Allen), fearing the scorn and rejection she will face at the hands of the community when her colored status is revealed, surrenders to David's tender application of black-and-white makeup. The makeup is later removed by Bill Johnson (Jeff Daniels)– owner of the local soda shop and the object of Betty's affection– revealing vibrant skin beneath. For the application scene, green-colored pancake makeup was applied to Allen on the set, then desaturated to appear gray. As the makeup was wiped away in the later scene, animators followed the contours of the actress' face to reveal her natural flesh tones. "We blurred the edges a bit so our work wouldn't look too abrupt," related Southard. "We also added an almost imperceptible amount of hazel coloration to her eyes, which makes her look just that much more alive."

Some of the color work was much more subtle, with Southard and the digital artists constantly tweaking and adjusting highlights, shadows and midtones to accommodate changes in lighting, or to help lead the viewers' eyes to the appropriate area of the frame. "If you put color in any frame," explained Southard, "even on a tiny object, human nature dictates that the viewer's eyes are going to immediately focus on that colored object– even if you need them to focus on the principal black-and-white actors. That forced us to do some compositional things, like dropping the saturation levels way down on the colored item, placing another item of color into the shot, or adding the slightest, almost imperceptible amount of color to the black-and-white objects in order to draw the eye back to where it was supposed to be."

The primary directive was to create a natural look within decidedly unnatural scenes featuring both colorized and black-and-white features in the same frame. Toward that end, subtle highlights were often cast on black-and-white objects or characters that were in proximity to colorized objects. In one scene, for example, David's love-interest Margaret (Marley Shelton) reaches up with her black-and-white hand to pick a colored apple from a tree. "You see a little red glow on her black-and-white hand," commented Ross, "which is the reflected kick light off the apple. We had to simulate those kinds of things in order to keep it real and not looking as if it was cut out."

The same sequence has the couple driving through a black-and-white landscape enlivened by bright pink dogwood petals swirling down from the trees. The effect was partially realized during production, with giant fans used to blow crates of petals from artificial trees on set. "The petals we shot were bright magenta," related Watts, "which provided enough contrast to pull mattes but was close enough to the intended color to allow for the inevitable imperfections. A matte was pulled for the petals, the scene was turned to black-and-

white, and the original petals– color-corrected to the intended pink– were composited back over the scene."

In defiance of a repressive town ordinance, David and Mr. Johnson paint a multicolored mural on the side of the Pleasantville police station.

"We went into the background of the scene and broke it up into basic shapes," Southard explained. "From there, we were able to pull different levels of mattes using inorganic shapes to encompass certain areas of falling petals. Using artistic license as well as common sense, we darkened the colors as they went further into the distance and lightened the petals closest to camera. Using multiple layers and animated mattes saved us a lot of time and effort, preventing us from having to literally move around millions of petals."

Black-and-white Pleasantville capitulates to color during the trial of the renegade artists.

After PVE applied its digital spectrum to the film, color timing– conducted primarily at CFC– became a crucial part of ensuring that the movie's visual palette remained intact all the way through to the final print stage. Watts and Southard oversaw the process of timing, balancing and contrasting the color and monochromatic effects. "After all of our work," Watts remarked, "we had to make sure that the color timer didn't get his own idea about how these shots should look."

Tasked with a gamut of zero-hour adjustments, from balancing the color and contrast of certain shots to cleaning up digital mattes and 'dust-busting' individual frames, CFC was nearly overwhelmed with the sheer scale of the endeavor. "We had never been swamped with that kind of volume before," stated Janet Yale. "We're used to feature film work coming into our facility at the rate of three or four shots a day. On Pleasantville, three-by-four-foot cardboard boxes containing twenty or thirty DTF tapes quickly became a normal sight. We had never encountered such a massive amount of incoming material. We would load the data in on Monday, the color timing would be accomplished on Tuesday, on Wednesday everything would go back out again– and then the process would repeat itself."

An elaborate set of protocols– followed by PVE and all the outside vendors– was imperative in making sure that the effects work remained virtually unchanged from inception to release printing. "Imagine a movie in which the characters all look at an effects shot and say, 'Hey, look at that!'" said Gary Ross. "That's what goes on throughout the movie. The effects are constantly being scrutinized by the characters, and so by the audience. That's why we had to be so exacting, all the way through release printing. That was crucial. It's like a stereo system– it doesn't matter how good your turntable is if your receiver sucks; and it doesn't matter how good your receiver is if your speakers suck. At any point in the process, the whole thing could have been screwed up. Chris Watts had to run herd over each step of the process, making sure that what ultimately got transferred to film was the same thing we'd had in each step along the way."

In addition to the digital saturation and desaturation work, Pleasantville had its share of straightforward visual effects. The fanciful ‘TV zap’ effect, which thrusts David and Jennifer into Pleasantville’s black-and-white surroundings, was a joint effort between Editel and PVE. “For that shot,” said Mark Robben, “our previsualization compositor, Wayne Shepherd, created a couple of temporary compositing effects, just to flesh out some test ideas for Chris’ group.” From there, PVE senior digital compositor Ron Kallesen created the final version of the scene, generating a digital vacuum effect in Media Illusion.

The film also featured several digital matte paintings, executed by Mark Sullivan of Compound Eye. “My favorite single shot in the entire movie,” stated Watts, “is an establishing shot of Pleasantville itself, in the aftermath of the town’s first rainstorm. It’s a hillside view of the black-and-white town, with color trees in the immediate foreground, a color rainbow extended across the skyline and mist visibly passing through it. It’s really beautiful. Mark did an incredible job.”

In the ranks of effects-heavy films, Pleasant-ville stands at the forefront of an emerging trend. Rather than being driven by visual effects, it uses them as storytelling tools to give added dimension to its characters and to create emotional depth in a way never before possible. “The infancy of any new technology is always just about the technology,” commented Gary Ross, “and then, as time passes, it evolves into something else altogether. Fortunately, that is becoming true of digital effects, as well. Pleasantville is only the first of many movies that are going to use this technology for more than just effects. It will be used for more complex and sophisticated forms of storytelling.”

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ANTZ
ROAD TO INSECTOPIA

article by Mark Cotta Vaz

Judging by recent trends, movie ideas come in twos. Last year it was volcanoes, with Dante's Peak and Volcano simultaneously vying for release dates and boxoffice dollars. This summer it was meteors threatening life on earth in Deep Impact and Armageddon. Soon thereafter, it would be two insect-themed productions, released within eight weeks of each other. Unlike those previous formula disaster films, however, both Antz, produced in a partnership between DreamWorks SKG and Pacific Data Images, and A Bug's Life, a Pixar Animation Studios and Walt Disney Pictures production, could boast a significant distinction: they were only the second and third completely computer animated features, respectively, ever released.

Toy Story, Pixar's 1995 trail-blazing foray into the then uncharted realm of feature-length computer animation, established the standard for a new medium and paved the road down which came Antz. In fact, if not for the artistic, critical and boxoffice success of Toy Story, PDI might still be out in the creative wilderness, searching for a major studio with sufficient belief in the medium to help the company expand into feature animation.

The Silicon Valley digital effects facility had made a name for itself creating everything from a CG doughboy for Pillsbury to virtual stunt performers for Batman Forever– even engineering a startling morphing breakthrough for Michael Jackson's Black and White music video. But PDI president Carl Rosendahl's dream, gestating since the mid-eighties, was to evolve from a service company into a computer animation studio. The dream was an ambitious one– and a long way from the flying logos and broadcast graphics PDI specialized in when founded in 1980.

By the early nineties, Rosendahl and animation group head Tim Johnson– who would eventually co-direct Antz with Eric Darnell– began making the studio rounds, proposing an all-CG feature. Universally, they were met with blank stares from puzzled executives who wondered why anyone would sit through an hour and a half of computer generated animation. "Despite the quality of our commercials reel and animated shorts we were showing them," stated Rosendahl, "they were picturing the old aesthetic of flat shading and vector graphics, chunky models and motions. The only one who 'got it' was Jeffrey Katzenberg, who was then at Disney and had already made a deal with Pixar."

Then on October 12, 1994, animation maestro Katzenberg, who had left Disney in bitter estrangement, famously stood alongside director Steven Spielberg and music mogul David Geffen at a press conference announcing the first studio start-up in over a decade. The vaunted 'dream team' agenda for the new DreamWorks SKG included animated features. By the end of 1995, PDI had entered into discussions with DreamWorks, talks that heated up considerably after the success of Toy Story.

Although PDI pitched the studio a number of its own feature ideas– notably Lights Out, about a microscopic world of buglike creatures– DreamWorks had another project in mind. Antz, the

saga of an ant colony, was in development at the studio, reportedly as a puppet production, but was considered a perfect fit for computer animation.

Antz is a grown-up fairy tale about life in an oppressive, subterranean ant colony, as seen through the jaded ant eyes of Z-4195– voiced by Woody Allen, in a rare outside project. A budding romance between Z and Princess Bala (Sharon Stone) takes the pair on a glorious, often frightening adventure to the brobdingnagian surface world in search of the fabled Insectopia. Looming over the colony is General Mandible (Gene Hackman), a maniacal army ant. The stellar voice cast, largely assembled through Katzenberg's efforts, would also include Sylvester Stallone, Anne Bancroft, Christopher Walken, Jennifer Lopez and Danny Glover.

In partnership with DreamWorks, Pacific Data Images created its first all-CG animated feature, Antz– about a worker ant who rebels against the institutionalized regimentation of his colony – innovating across the digital spectrum to complete the project in record time.

Considering the lengthy time frames involved in producing computer animation, the speed with which the production was consummated was astonishing, going from concept to screen in only two and a half years. Even A Bug's Life, produced by the veteran Pixar, required more than three years to complete. Though started later, Antz would beat A Bug's Life to theaters– nearly six months ahead of its originally announced release date– and also be in release ahead of DreamWorks' own traditionally animated The Prince of Egypt. "When PDI and DreamWorks shook hands to work together," noted Rosendahl, "PDI had ninety people working on commercials and feature films. DreamWorks was working on Prince of Egypt and getting The Road to El Dorado into the pipeline. And Antz was only a paragraph-long idea."

A lengthy opening monologue in an ant pyschiatrist's office has worker ant Z-4195– voiced by Woody Allen, one of many A-list actors recruited for the film– expressing neurotic discontent over his lot in life.

The project required a total ramping-up at PDI, with the company growing nearly threefold to 260 employees. An organizational restructuring was also called for to accommodate everything from communications flow with DreamWorks to adapting a feature film production model. Bringing live-action feature savvy to the proceedings was Aron Warner, who would share Antz producing responsibilities with Brad Lewis and Patty Wooton. "My job was to impose a live-action-feature structure where there'd never been a structure," Warner explained. "PDI previously hadn't had to schedule anything more than three months ahead, hadn't managed a

budget over the course of two to three years. I took what I knew of scheduling and budgeting and impregnated the system with it, as well as brought a production management style of dividing tasks among different groups. All these great generalists had to become specialists that would fit into a production pipeline. But I knew I couldn't come in like Mr. Hollywood, yelling and screaming. Animators have to be nurtured and fostered. There's a lot of person-to-person care that goes into doing a CG film. It's more than the technology– it's a small group of immense brains being put to use."

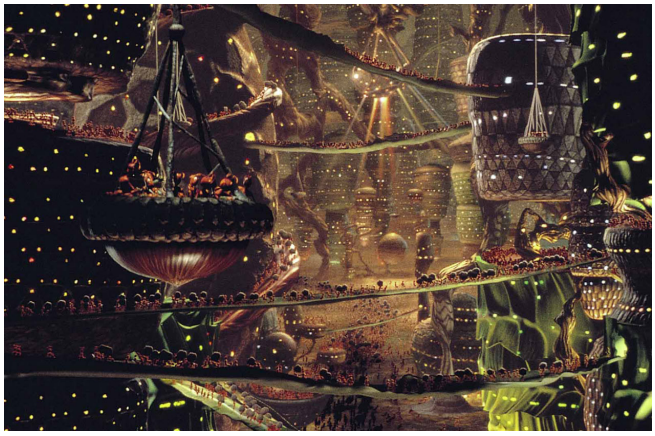
PDI did not come into the venture cold. For years the company had been putting a creative and technological structure in place, anticipating just such a feature production opportunity. A proprietary animation system– honored with a technical achievement award from the Academy of Motion Picture Arts and Sciences in 1998– had been evolving ever since the company's founding, and provided Antz with a virtual production environment into which software tools created by the research and development staff could be used in-tegrally by technical directors, motion animators and other departments.

Hand in glove with the architecture of the animation system was the character animation group, co-founded in 1990 by Tim Johnson, then joined by Eric Darnell in 1991. Wholly concerned with character animation, the group would develop the skills of motion artistry and conjure ideas that the R&D division could fashion into proprietary tools. On Antz, the fruits of the group's and the R&D department's efforts included a facial animation system that emulated the full physical range of human expressions, a crowd-creation system that provided a library of behavioral controls applicable to thousands of individual characters, and water simulation that realistically captured the dynamics of flowing water.

With six years of that kind of development un-der its belt, PDI was primed and ready for a project such as Antz. Initially working without a script, the company developed the spine of the narrative in beats, with each beat briefly outlined. "A beat outline would be: 'Z enters a bar, hopelessly depressed, meets the princess, the girl of his dreams, and they have a dance together,'" Tim Johnson explained. "That's all we needed to get going. Once we had all the sequences at that level, we could track the characters' progress. We did these beat outlines even before storyboarding, before a script happened."

As it was finally developed, the storyline would have a harder edge than typical kiddie-safe animation fare, beginning with the opening sequence in a psychiatrist's office. Stretched out on the couch and unburdening himself to his shrink is Z, who confesses to feeling woefully out of place in the teeming colony. The doctor commends his patient on a breakthrough: Z has finally realized he is insignificant. Such hints of adult angst would distinguish Antz from other animated films. "We wanted to keep it in the family genre without making it a toddler flick," remarked Johnson. "We also wanted to make a film more aggressive in terms of a live-action look and feel; and this medium lends itself to that."

A live-action style was adhered to throughout production, from the design to the cinematographic concerns of layout and lighting, beginning with the opening scene, which transitions through the psychiatrist's office window to reveal a Manhattan-sized ant domain of carved rock columns, bridges and tunnels. Although it was the kind of spectacular establishing scene into which many a virtual camera has flown with abandon, the sequence was instead shot to impart a live-action feel. "To have a CG camera flying with limitless movement would have been an awful way to start the movie," stated Simon J. Smith, head of layout, the department that dealt with virtual camera concerns. "The directors and I agreed to go into the environment with four or five separate shots, limiting the virtual camera to certain moves, such as an arc line to make it feel as if our camera was on a boom arm, filming a large set. Throughout, I tried to put as many live-action idiosyncrasies into the camera work as possible, including subtle delays in the pans and tilts to make it feel as though somebody's reacting behind a real camera, not sitting at a sterile computer, churning out predetermined linear moves."



An establishing view of the bustling ant colony. Complex environments filled with hundreds, sometimes thousands, of ants provided scope for the film.

Worker ants form a wrecking ball to excavate a vast subterranean chamber.

The production process itself was also similar to that of a live-action feature, starting with a conceptual phase during which 2-D storyboard art was created to nail down the look and dynamic of each scene, with story panels digitized and cut together on an Avid. Next on the production pipeline was the layout department's virtual camera design, followed by animation and a final lighting and rendering phase. As structured as the production pipeline was, however, the cold reality was that everything was constantly in a state of flux. "It is not a linear process," stated Eric Darnell. "But what seems to be the curse of this process is also the blessing. We were changing things all the time, even going back to storyboards and modifying them, then popping them back into the pipeline. As long as there was another day, there was always something we could make better."

The project was launched with a massive art department effort, headed by production designer John Bell. Early on, ground rules were established for the world they would be building. "Eric and I decided the big maxim was that this was never going to be a movie about how small the ants were," Tim Johnson noted. "It was going to be about how huge the world was." Another early decision was not to incorporate human beings as characters. Though located in New

York’s Central Park, the ant colony would not feature underground pipes or other evidences of human surface dwellers. Even the above-ground world– explored by Z and Bala and seen through their eyes as impossibly vast– would not feature people, as such. In the ‘shoe-to-shoe rescue’ sequence, for example, in which Z and Bala become stuck to chewing gum on the sole of a tennis shoe seemingly as big as an ocean liner, the striding human is visible only as blue-jeaned legs towering like twin skyscrapers. “From an ant’s perspective, a human being is taller than the Sears Tower. Including entire human beings in the frame would be like trying to photograph Mount Everest in its entirety from base camp– impossible!”

Designing shots from an ant’s-eye view was a constant challenge. “It was easy for our artists and art department to get down to the POV of a mouse,” Darnell commented, “but it was really difficult to get down to the ant’s perspective. We were always checking ourselves: ‘Have we really scaled the camera a fifth of an inch off the ground?’” Several creative approaches cracked the scale issue, such as a mind game in which scale comparisons were contemplated: ‘Imagine looking up at a redwood tree; now imagine it’s a dandelion. Now you have the ant’s perspective.’ The earthen colony itself was designed at the scale of a person standing in the middle of Manhattan.

Smitten by Princess Bala– slumming incognito in a worker’s bar– Z approaches her boldly and the two engage in a nonconformist dance.

On the practical side, John Bell got his art department down to ant level by literally looking at the world through a peep-hole security magnifying lens, such as those mounted on the front doors of homes. “We’d take these peep-hole telescopes– which provided a great fish-eye distortion quality – and get down on our hands and knees,” recalled Bell. “That helped force the perspective of things. It made a can of soda look like a water tower!”

Final production designs benefited from the inestimable input of Steven Spielberg, who was very involved in Antz during the project’s early stages. “Some of our early designs were just too man-made looking,” Bell admitted. “Steven emphasized: ‘This isn’t our world. Let’s make another world.’ He was always striving for a more organic look. We ended up building the colony with a palette of natural elements– twigs and rocks, grass, leaves and acorn shells, mushrooms and crystals. One big issue was getting light into this underground world; so we came up with an amber geode above the town center. This is the Queen’s royal chamber; but it’s also suspended by roots that we theorized the ants have hollowed out, allowing sunlight to creep down and hit this crystal with a golden light that spreads throughout the colony.”

The genesis of the characters began with the look of Z– developed by lead character designer Raman Hui, who was responsible for designing the ant characters, while freelancer Shannon Jeffries designed the wasps– but it took an estimated two years to get all the characters completed and into the pipeline. The opening in the psychiatrist’s office– which was also the opening sequence for the entire production– allowed PDI to set sail while developing other characters and sequences. “It was a really easy scene to start with because it’s a monologue

taking place in an office," Johnson noted. "That environment was much simpler than the complex environments we would be creating later. Also, the writing and Woody's performance in that sequence were both great; so we knew it wasn't going to change."

The art department's conceptual illustrations and 2-D story reels were ultimately brought into a 3-D environment by the layout team, which determined camera moves and angles on a shot-by-shot basis. Layout would generally require several days to build the physical particulars of a shot, with the modeling department providing low-resolution models of the characters, props and environments. "We'd take those low-rez characters and move them toward camera to make sure the rough movements were working properly," Simon Smith explained. "It was like setting marks on the floor for actors. We'd spend two weeks doing this 3-D plotting with the low-rez characters and rough sets, determining the edit speed and rhythm. We'd also think ahead to how lighting or effects would affect a shot. Most importantly, though, when I got together with the directors we'd discuss the feeling of a scene. In the final stage we'd put in all the set dressing, still tweaking camera and character movement. After the final layout was approved, the motion animators could then begin animating our base movements."

Antz required PDI's expanded modeling department to create some six hundred primary models and approximately five thousand total models, a figure that included every computer generated rock and other bit of set dressing. Since physical sculptures, digitized, would often serve as the basis of a digital model, PDI set up a traditional sculpting unit within the modeling department. Outside vendor Viewpoint DataLabs also collaborated on the digitizing and modeling effort, doing some on-site work at PDI. Viewpoint took pains to ensure that detailed character models had clean surfaces so that PDI could create complex deformations and animate effectively. Once a sculpted model was scanned, the computer model could be tweaked, or even completely redesigned, with new physical properties added.

Each animation model– made up of approximately one hundred separate pieces and almost 140,000 polygons– also had to be equipped with 'connectivity information,' without which the parts of the figure could not hang together in motion. "Our basic surface element is a patch," explained modeling supervisor Konrad Dunton, "a geometric element that in essence is a square grid. Every little detail of the model tends to be a separate piece of geometry. To make sure all those surface elements are continuous, our proprietary software adds information to the data set, allowing these surfaces to move together and not come apart at the seams when animated."

Environments were modeled in a variety of ways, from scripts designed to create specific geometry to the use of commercial software. For a foreboding world inside a rotted tree stump– the domain of the termites, territorial rivals of the ants, and the place where the two factions clash– the modelers used as their foundation a digitized styrofoam-carved model. "The termite colony in the old tree stump was the most challenging environment for the modeling department," Dunton commented. "It not only had a huge number of polygons, it was one of the first environments of that magnitude we created. So we tested both new modelers and the production pipeline capacity with that set."

Some environments contained as many as two million polygons. Z and Bala's ant-sized perspective in the shoe-to-shoe rescue, for example, required several complex models for the

tennis shoe alone. “We had a special model just for the closeup of the shoe lace, which was around 800,000 polygons,” recalled Dunton, “while the shoe itself was around 500,000 polygons. It’s amazing what we crank out now, in terms of polygons. When PDI started, the company was working with thousands of polygons– now we’re talking about millions.”

The finished character models, though highly detailed, still awaited the spark of life provided by technical directors, who not only equipped each character model with a skeletal armature, but mathematically encoded all of its specific movement capabilities. For Antz, the programmed controls specified everything from each ant’s malleable exoskeleton to the dynamics of its antenna. “We’d sit with the animators and custom-tailor controls that would allow them to animate faster,” noted character technical direction supervisor Beth Hofer. “Controls are the actual values, what you tell the character to do, and they can be built in for certain behaviors, such as the shoulder shrugs characteristic of Z. We built that engine and gave the animators the controls to run it.” Animation-friendly controls meant that instead of an animator having to manipulate every digit of a finger to close a hand, a simple ‘curl’ control would create the action automatically. Also, since lip sync is a time-consuming animation task, characters were designed with the ability to have expression controls changed without changing dialogue controls, thus allowing revised performances to be created while retaining the original lip sync.

The character setup stage was where the facial animation system was integrated. The breakthrough software was considered vital for orchestrating the highest level of virtual acting. “We didn’t want this to be a cartoon,” remarked supervising animator Rex Grignon. “We wanted to get more into the subtlety of emotion, creating a dramatic film with real performances that people could connect with.”

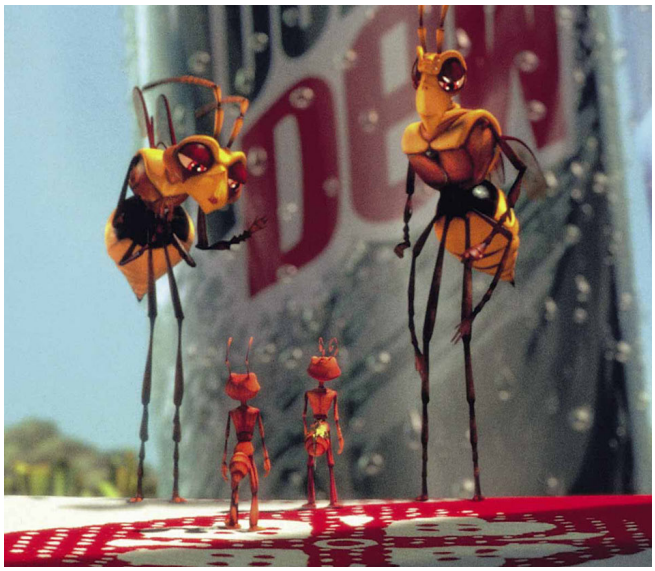
Posing as a soldier ant to catch a glimpse of Bala, Z finds himself swept into battle during a nigthtime assault on a termite colony.

The facial system was in development for nearly two years, an effort helmed by technical director Dick Walsh. Extensive research into the properties of the human face was conducted to produce a system that would emulate the structural layering of bone, muscle, fat and skin. “Typically,” explained Hofer, “CG faces are animated with what we call shape interpolation, where facial expressions are built and blended. Other work has been muscle-based. Ours was really a new approach of literally building all the facial layers, mimicking the way a muscle slides over the bone, the way skin might compress or stretch in reaction to that muscle movement. It gave us amazing subtlety in our facial expressions.” The facial system included expression controls capable of grouping together underlying muscles. Even a small movement, such as the widening of an eye, would contract all of the related muscle groups. “There are three hundred muscle contractions in a human face– and we didn’t want the animators to have to animate each one individually. They would have killed us!”

Grignon and Raman Hui– doubling as supervising animator and character designer– were particularly involved in the control design stage. For the facial animation system, Hui created a series of drawings formulating ranges of expressions, pinpointing what would be needed in the facial system controls. “We boiled it down to a minimum set of controls,” Grignon noted, “because if there are too many, it becomes very difficult to animate the face. Dick Walsh also made it very difficult to ‘break’ the characters’ faces, so to speak, which made it easier to keep the characters ‘on-model’ throughout the film. It allowed us to get a lot of consistency, even though a number of different animators might be working on a specific character.”

In a series of bickering misadventures outside the ant colony, Z and Bala flee an incinerating beam created by a child’s magnifying glass and later encounter a pair of snooty wasps.

Before motion artists could begin the anima-tion, the voice talent’s recorded performances had to be ready. But early in the production, when 2-D art panels were being cut together on the story reel, a PDI volunteer often sufficed as a voice stand-in. “When we began,” recalled Eric Darnell, “we didn’t have Gene Hackman’s recording, for example. So we’d pull somebody out of the hall, and say, ‘Come on, you’re Mandible!’ They’d do the performance and we’d cut it in at that very early stage.” Recording sessions eventually conducted with the actors spanned the country from Los Angeles to New York to San Francisco. “We didn’t necessarily bring the actors into the same studio, even if two characters were having a back-and-forth exchange. It was a funny thing: there might be a scene where two characters were arguing, and we’d go direct one side of the argument in New York in February, then direct the other side with a different actor in L.A. in July! It was challenging for the actors– and it was criti-cal for us as directors to be the conduit between the two.”



In a series of bickering misadventures outside the ant colony, Z and Bala flee an incinerating beam created by a child’s magnifying glass and later encounter a pair of snooty wasps.

“Those sessions could be very draining for the performers,” said Johnson. “They were faced with just a microphone in a brightly lit studio. There were no costumes or makeup, and they had to be in this emotional space, in a fantastic environment that they couldn’t see. It really challenged their imaginations. But the power of these actors’ imaginations is why they’re

successful– and we pressed that power to its limits. The animators had to have a bit of the actor in them, as well. They had to take the emotions of the audio performance and identify with the inner truth of that performance. It could be as subtle as adding a grimace in the mouth to show the fear behind a line of dialogue."

While the studio recording sessions were videotaped to provide a visual reference for the animators, both the physical personas and individual vocal characteristics of the performers were considered only starting points for the alchemical process of imbuing a computer generated character with the illusion of life. "After a while," commented Raman Hui, "it wasn't Woody Allen anymore. We'd look at the character and it was just Z."

"Early on," added Rex Grignon, "characters are just drawings and models– they aren't evolved. But once you get a body of animation done and you start seeing a character come alive, you realize, 'Oh! That's what Z is!' Part of what Raman and I and directing animators Sean Curran, Donnachada Daly and Denis Couchon did was recommend to the animators how to add a particular 'Z-ism' or make a performance more like Mandible." Where possible, animators were assigned specific characters– Hui was most often the animator behind Z, for example, while Grignon handled Mandible. Since the thirty-person animation unit was not always large enough to give an individual animator exclusive ownership of a character, however, sequences were usually divided among the animators, with a single character being animated by several different artists.

Animation started with its own rough break- down stage, during which the audio track would be called up on the computer so that the animators could delineate, frame by frame, where sounds began and ended. Once the timings were worked out, the artists could explore the emotional content of the spoken lines and imagine the virtual performances they would be creating. Shots were also plotted out before animation, with Hui making initial sketches of characters and scenes, hitting the key poses and emotive qualities that would then be imparted in the actual animation.

The versatility of the animation system allowed animators several options in posing their characters. "We could interactively set a position for certain joints at a point in time," stated Grignon, "and the character would move through different settings. Or we could go to a particular frame and type in a numbered value." Although the computer could interpolate between key poses, animators still had to continually adjust and compensate to create organic movement.

Plugged into PDI's animation system was their breakthrough crowd software, another vital component since depicting the populated colony within the story would necessitate a staggering five hundred crowd shots. A means of producing realistic crowds numbering from the dozens to tens of thousands, without resorting solely to time-consuming key-frame animation, had to be developed. "From the beginning, the directors emphasized that this was a movie about an individual inside a world he doesn't like anymore," observed Luca Prasso, technical lead for the crowd scenes, "a colony with millions of ants working, marching, fighting, digging. The main challenge was how to animate crowds and show individual ants interacting and looking slightly different from one another."

That challenge was met with a two-pronged package. Prasso developed a blending system for scenes featuring up to fifty characters; and a crowd simulator was developed by Juan Buhler and Jonathan Gibbs for masses ranging from hundreds to thousands of characters. “The blending system simplified the work for animators by allowing a lot of variations to be created semiautomatically with a user library of blending tools,” related Prasso. “Instead of an animator having to worry about every foot or finger position, behavioral controls allowed the system to take assigned motion from a library of cycles. Animators could blend and create new motion from existing motion, such as going from a walk to a run cycle. The system is also capable of taking the emotion of one character and applying it onto a different, but typologically similar character, even assigning different physical attributes, such as physical proportion and head shape.”

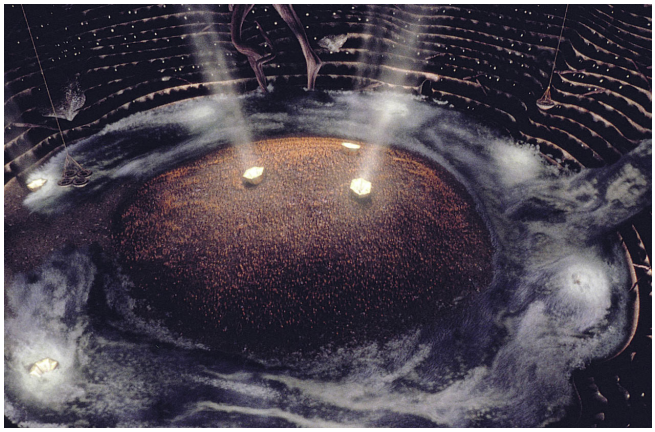
Z ponders how to rescue Bala, stuck in a wad of chewing gum on the bottom of a tennis shoe. Humans– when featured at all in the film– were presented solely from the perspective of an ant.

The blending system was also designed to provide motion cycles for the massive crowds handled by the crowd simulator. Nearly nineteen hundred distinct cycles were created for Antz. Essentially a physically-based particle system, the simulator used the motion cycles to drive the ants through the environment while avoiding obstacles and collisions between characters. “Animators could design trajectories, directions and goals for where they wanted characters to go,” explained Prasso. “It allowed for all the variations in size and activity that your brain perceives as a crowd. The simula- tor was also able to create complex combinations of motions where characters would automatically pick among the different cycles available, based on user-defined rules.” During production, the crowd system rendered an average of two thousand characters per shot– all 3-D. “In the past, crowds were rendered with 2-D, pre-rendered texture cards– but that posed problems with complex lighting conditions or when the camera moved a lot in the shot. It also meant millions of pre-rendered images to be handled. A full 3-D rendering approach allowed us to be free when designing the shot from a composition, camera, animation and lighting point of view. Our proprietary techniques could render as many as eighty thousand characters in 3-D, with reasonable rendering times, while maintaining a high level of complexity. It was fast and allowed for accurate texturing, lighting and shading that you can’t achieve with tricks, like replicating crowds in 2-D. The directors were able to direct a crowd scene just as in a live-action production shot with thousands of extras.”

Lighting and rendering awaited at the end of the pipeline, a stage that included the texturing of all surfaces. “The texture stage is not so much a paint process as a layering process,” stated Paul Wang, who with Craig Ring, Janet Rentel and Jean N. Cunningham supervised the film’s lighting. “For a complex surface like skin we might have layers for fine texture, diffusion, color, bump, sheen and reflectivity. But everything else needed texture, as well. On the shoe-to-shoe rescue, a shader was written for the distinctive way blue jeans pick up light. These textures could be procedurally generated, or they could be made up of 2-D art a texture painter could map onto a 3-D surface.”

Fulfilling their quest, Z and Bala come upon the fabled Insectopia– several invitingly overstuffed trash barrels at a public picnic ground.

Virtual lighting required all the normal considerations of live-action cinematography, from defining lighting characteristics of materials in a scene to adding specific fill, bounce and rim lights. The roughing-in stage involved low-resolution raw animation and a three-dimensional ground plane, with the lighting artists placing light icons in a manner similar to real-world lighting instruments.



A new water simulation system with dynamic motion controls was created for scenes in which the ant colony is threatened by mass flooding.

Early on, the lighting department realized that conforming to a traditional model for animation production would not work in a 3-D environment. “The model for how to do an all-CG film was something we made up as we went along,” noted Craig Ring. “In traditional animation, to make sure they’re on schedule, productions set quotas of a certain number of feet per week. We started out doing that and ended up with two beautifully lit shots from the same sequence that didn’t work in continuity. When edited together, the shots looked as if they were from two completely different environments. So we started finaling shots as groups within specific sequences.”

“A big part of lighting is continuity,” added Wang, “not only between sequences, but within a single sequence. We were always trying to balance aesthetic concerns with continuity concerns. One aesthetic advantage of lighting in the computer is that you can get things you can’t get in the real world. In live-action, you might want a rim light for the side of a face; but you can’t physically do it because the lights would illuminate objects you didn’t want lit, or you’d need twenty bounce cards in place. With computer graphics lighting we can create the impossible and make something as beautiful as we want it to be.”

But the lighting has to serve the story, without becoming a jarring effect. Maintaining appropriate subtlety was especially difficult in the film’s many underground colony scenes

where characters had to be lit and seen clearly enough to let the audience respond to them, despite the fact that they were in a dark environment. “We had to walk a fine line,” Ring remarked. “We might bring the fill light on the face down a bit, or have a bright highlight on one edge. We always had to check to make certain we hadn’t gone too far. We’d have the directors describe the action and where they expected lights to be– maybe the character would be standing in darkness, for example, and then step into the light as a reveal. We’d do the lighting as discussed, then show it to the directors; and they’d say whether they wanted it darker or brighter, or they would final it.”

As in a live-action film, special effects would embellish the story, sometimes even taking center stage. “We had approximately 760 effects shots in the film,” said effects supervisor Ken Bielenberg. “The amount of effects work in Antz was equivalent to that of a big summer blockbuster effects film rather than a traditional animated movie.” While most of the effects in Antz were subtle– such as footfalls of dust as Z and Bala patter along a piece of surface dirt that looks vast as a desert– there were visual spectacles, as well. In particular there were many types of water effects, including a raging flood, a water drop and a large puddle– big as a lake from the ant perspective– which General Mandible and his minions redirect in an attempt to drown the colony. One of the more dramatic water effects was the resulting flood where the colony is engulfed by water– which, to ant scale, was a tsunami wave.

Like fire, hair and other organic substances, water has always been one of the Holy Grails of computer generated imagery. “Water is one of the classic effects challenges,” Bielenberg remarked, “both in live-action and computer graphics. Water simulations have been, traditionally, very hard to run and art direct.” Marking a breakthrough in the simulation of organic substances was the flood water, which was able to flow and crash over itself and interact with objects. The fluid motion system was created by Nick Foster in the R&D department, who brought with him his doctoral research on water simulation for animation. The system for rendering the dynamic, crashing water shots was developed by Apurva Shah, a lead animator in the effects group.

The motion system encompassed a two-stage process in which a physically accurate flow field was first calculated using fluid dynamics. Then particles representing the water were tracked through the system. As with live-action effects, where a set might be configured or explosive charges placed to dictate a desired path or spray effect, flue controls allowed the shaping of the synthetic water flow. “We were able to get enough iterations and put in enough animation controls that we could art-direct what was happening,” Bielenberg stated. “We’d essentially set up hoses on one end to control water coming into the scene. Then we might place a rock where we wanted the water to hit and splash, and the water automatically reacted. We could take out a splash, or make a wave go higher in one area. To create foam particles we’d have objects we nicknamed ‘eggs’ in the simulation space. When the flowing particles hit these eggs, they’d turn into foam particles. In the final step, we used the commercial software package Dynamation to add mist and a fine layer of particles on the leading edge of the wave, which we’d then render with our proprietary tools.”

This and other breakthroughs were the mega-leaps that enabled Antz to be released ahead of A Bug’s Life. Despite any perceived competition with the other film or another animation house,

PDI had been considering an earlier release date from the very beginning of the project– the intention being to avoid getting sucked into the gravitational force of the first Star Wars prequel. The turning point was a November 1997 screening of the work in progress for Spielberg, Katzenberg and Geffen. Although the picture was mostly storyboards at the time, with a temp mix soundtrack, most of the recorded voice talent and about twenty percent rough animation, the dream-teamers loved it and urged PDI to accelerate production for an earlier release.

The company realized that with a little extra organizational boost, an early release date was indeed within reach. “We asked PDI’s production managers, who were really the brains behind scheduling, to estimate what it would take to make an earlier release,” recalled Aron Warner. “It meant working people a little harder early in the production– but by doing that, we avoided the seven-day-a-week, twenty-four-hour-per-day crunch that happens at the end of a lot of shows. There was still pressure at the end, but it wasn’t like people were in tears all the time and had to sleep over. Overall, making an earlier release meant increasing the weekly footage, increasing our render farm capabilities so as not to have a bottleneck, adding people to certain departments, and a little more overtime.” What the early release would not mean was compromise, corner-cutting on the animation or excising of complex sequences just to make the new deadline.

By the end of production, PDI had not only met the challenge of making a full-length computer animated feature in record time, it had set in place a production pipeline that was fully functional and ready to serve future films. In fact, even as Antz entered theaters, PDI was in the midst of plotting an eighteen-month animated feature schedule and already well into preproduction on Shrek, the second DreamWorks/PDI collaboration.

Though PDI higher-ups had dreamed of such a project for years, no one fully comprehended what would be demanded of the company when the Antz endeavor was first launched. “Frankly,” stated Eric Darnell, “I’m thankful that I was so naive about what we were up against when we started the production. I was just bright-eyed and bushy-tailed. ‘What fun! Let’s make a movie!’ But it was a huge undertaking. Computer animation is such a new medium, one that has been used mostly to generate effects. But now I think we can say we’ve come into our own. It’s no longer just about effects. It’s a viable medium for bringing compelling stories and characters to the screen.”

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A BUG'S LIFE
AN ENTOMOLOGICAL EPIC

article by Mark Cotta Vaz

It was in the magical, toy-filled bedroom of Toy Story that cowboy doll Woody and space toy Buzz Lightyear vied for the affections of a boy named Andy. Not only did that 1995 film win the hearts of audiences, establishing Woody and Buzz as instant icons in the pantheon of animated characters, it did so as the first completely computer generated feature. The historic production could have failed, like an experimental rocket ship exploding on the launch pad, but liftoff was more than achieved. Toy Story, produced in a partnership between Pixar Animation Studios and Walt Disney Pictures, generated an estimated $350 million worldwide and critical acclaim crowned with a 1996 Special Achievement Oscar.

A second Disney/Pixar venture was thus assured. It was, in fact, already in the works even before Toy Story hit theaters. But A Bug's Life– that second co-production– would be considerably more than a mere follow-up, representing nothing less than a major creative and technological leap for the young medium of computer animation.

The creative work force at Pixar, headquartered in the San Francisco Bay area community of Richmond, seems to revel in the opportunity to make film history. Indeed, they have been making it, in one form or another, for nearly twenty years. The seed of the company was first planted at Lucasfilm in 1978 when George Lucas directed his nascent computer division to develop a digital printer. The group also made explorations into the 3-D world of computer animation, helping lay the building blocks of computer graphics for motion pictures. Although the Lucasfilm computer department enjoyed early highlights, such as the 3-D 'Genesis' sequence in Star Trek II, the creative principals had their hearts set on using computers to tell stories. In 1986, the group– which included Ed Catmull, John Lasseter and Bill Reeves– was purchased from Lucasfilm and reorganized as Pixar Animation Studios. Armed with some of the tools it had created – most notably RenderMan– the company began advancing the 3-D medium in everything from its Oscar-winning 1988 short Tin Toy to TV commercials for products such as Levis and Listerine. Then, in 1991, Pixar inked its breakthrough partnership with Disney– a collaboration that led to Toy Story, and now A Bug's Life.

With its latest film, Pixar has opened up what could be called the 'third reality,' that visual realm where dimensional photorealism fuses with illustrative flourishes and freedoms. "The most amazing aspect of this medium is that you can create your own reality," technical director Keith Olenick observed. "Everything is art directed and production designed, every little rock and grain of sand. I don't think this ability to design and then build everything has happened before in films."

The Bug's world would not only take audiences down to insect scale and get close up on everything– traditionally a bugaboo in computer graphics– but inhabit organic landscapes lit with a glowing luminescence rarely seen in a live-action feature, much less a computer generated one. Bringing the vision to the big screen was a four-year production journey during

which Pixar increased its organizational and technical capacities in virtually every area. The employee headcount zoomed from 175 in 1995 to some 400 in 1997. In addition, the company's core proprietary systems– such as Marionette, concerned with modeling, animation and lighting, and RenderMan, the shading and rendering tool– would undergo transmutations.

Technological breakthroughs included new 'subdivision surface' modeling technology, a joint endeavor between the shading and lighting departments to create an 'illumination model' for translucent effects and a live-action palette of virtual lighting possibilities, a proprietary crowd system for animating and rendering the denizens of the ant colony around which the story revolves, the use of a state-of-the-art digital editing system to manage the tens of thousands of shot iterations, and a host of other developments, including a rain simulator. And as if to underscore that the filmmakers had blasted light-years beyond the suburban neighborhood of Toy Story, Pixar, with Disney's corporate blessing, produced the entomological saga in the widescreen CinemaScope format.

Mistaking a troupe of circus insects for heroic warriors, Flik– an ant whose colony is being victimized by ruthless grasshoppers– recruits the inept performers to help in A Bug's Life, the second all-CG feature from Pixar and Disney.

In every way, A Bug's Life would live up to the marketing department's promise of 'an epic of miniature proportions.' From the large cast of main and supporting characters to the organic environments to the anamorphic format– which created an estimated twenty-seven percent more screen space to be filled– the challenge and scope of A Bug's Life could be boiled down to one telling statistic. To create the animated film, Pixar had to ramp up the RenderFarm, its vaunted nerve center of computer power, to twelve times the processing employed on Toy Story.

Flik, a hapless dreamer, tries his best to impress Princess Atta with a harvesting device and a makeshift telescope he has invented.

The story for A Bug's Life was inspired by the classic Aesop fable of diligent ants who tend their crops during the sunshine months while a neighboring grasshopper plays. Come winter's grim reality, the ant colony enjoys its harvest and denies any charity to the lazy grasshopper. The creative team at Pixar decided to turn the fable on its head, conjuring up an ant colony forced to pay an annual tribute of harvest to a grasshopper gang

led by the menacing Hopper. Flik, a bumbling but ever-earnest ant, decides to journey from the colony to find a band of warriors capable of defending against the predacity of Hopper and his cohorts. Unfortunately, Flik mistakenly returns to the colony with a bedraggled troupe of failed circus bugs who are woefully unprepared for the battle ahead.

Flik, a hapless dreamer, tries his best to impress Princess Atta with a harvesting device and a makeshift telescope he has invented.

Unlike a live-action production, story development for a computer animated feature does not flow directly from the screenplay. Although a script is developed, the visual complexities of the medium put the emphasis on the storyboarding of literally every shot, an evolving process that builds towards a final digitized 2-D story reel. On A Bug's Life, this phase took fully half of the four-year production timetable, with the actual filmmaking overlapping in a two-and-a-half-year schedule. The development of the story was a struggle, with some of the twenty-six sequences that comprised the movie being redone as many as thirty times. "Whenever I'm asked how Toy Story became such a good story," stated co-director Andrew Stanton, "I say, 'Rewrite, rewrite, rewrite.' I've likened the story development phase to an archeological dig. All you're doing the first couple of years is digging and finding a couple of bones; and from those you predict what the dinosaur will look like. Then you find more bones, and it's not exactly what you thought. You have to dig deeper until you find the whole thing."

In Disney parlance, there are names for the inevitable creative crisis when a story-in-progress is revealed to have a gaping hole in its design or a character refuses to come to life. During production of The Lion King it was called the 'story meltdown.' On Aladdin it was called 'Black Monday.' Pixar had visions of its own Black Monday while reviewing the early, evolving story reels of Toy Story and encountering a minefield of problems, notably a bullying personality for Woody that was soon dropped.

There were a few bumps in the story road of A Bug's Life, as well. The original idea featured the central character of Red, a little red ant who is part of a circus troupe down on its luck. Desperate for a paying gig, the circus ants present themselves to the ant colony as saviors, the answer to their troubles with the grasshoppers. With six months' worth of storyboards drafted and ready to go to the 2-D story reels, the filmmakers decided that the scen-ario left too many plot holes. "We started thinking, 'What if you had a lonely guy who goes out to get help for his family?'" Stanton recalled. "'And what if this left-of-center person in the colony, despite the best intentions, went out and made the ultimate mistake of getting the wrong people to defend the colony?'" On his own Stanton rewrote the script, untangling the knots of plot points and transforming the circus ant Red into Flik, a member of the colony. "We had our main character, the little red ant, in the wrong camp. The answer seems so obvious now; but at the time, when you're in exploration, everything seems possible."

One of the questions the team had grappled with during story development was why the circus ants would stick with the colony when the going got rough. “We figured out why the circus insects stay at the colony during the sequence called ‘Dot’s Rescue,’” related storyboard supervisor Joe Ranft. “A bird attacks the circus insects; and while they’re trying to save their butts, they end up saving this little girl ant, Princess Dot. The colony goes berserk and is applauding and the circus insects are wondering what that strange sound is. And Manny, the praying mantis magician, says, ‘That, my friends, is the sound of applause!’ They’ve been hungry for applause; so they stay.”

Unaware that Flik has ruined the offering they have left for the grasshoppers, the ants make their way underground, only to be confronted by Hopper, leader of the greedy extortionists, who angrily demands an even larger bounty.

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Ranft– a veteran of such dimensional anima-tion productions as Nightmare Before Christmas and Toy Story– and his eight-to-ten-person department created masses of storyboards during the visual exploration of major sequences. “I’ve coined it ‘stor-re-boarding,’” laughed Ranft, “because we redo and refine and make so many discoveries. You see something in a written script and there are so many interpretations in everyone’s mind. Part of the challenge is exploring all possibilities before we find the best possibility. Then you see a drawing of it, and it makes everyone’s point of view more concrete. We also worked closely with Lee Unkrich and our brilliant editing department, which pointed out editorial things we might not have been thinking of.” Discarded options ranged from a tree log hideout for Hopper and his gang to an entire sequence charting the history of the ants and grasshoppers through ancient hieroglyphics.

As in Toy Story, the boards were initially drawn up in black and white. Eventually, however, the artists turned to color as a means of more clearly identifying different characters and environments. “We had so many characters in this movie– the circus ants, grasshoppers, the primary characters of the ant colony– that when we were putting the boards on the early reels it was confusing,” Ranft noted. “We’d be trying to figure out: ‘Is that Manny? Is that an ant?’ There were scenes with dozens of characters running around. So just for identifying purposes we started to color our characters– which also made our boards look better.”

Final environments included Ant Island, a piece of earth and a tree rising above a creek bed, and The City, a melting-pot of insect life existing under the porch of an old trailer. Ant Island was designed as a wilderness spot, both exotic and familiar. “I equated going to Ant Island as a journey into the Amazon where you’re traveling through miles and miles of rain forest before you finally come upon a village,” director John Lasseter observed. “It’s as foreign as you can

imagine; but the more you observe it, you see the husbands working, the wives taking care of the kids, the kids playing. A familiarity sets in. We had always envisioned this anthill as being there for generations. It is this little island where the ants feel protected; and so they are nervous about venturing beyond it."

Eventually, the boards were cut together in a 2-D story reel. "You can't short-change story development," stated Lasseter, who was also the guiding force on Toy Story. "The story reel has to work in and of itself, with only still drawings, scratch voices and temp music. If the story reel doesn't work, all the added stuff– the models and textures, the animation and lighting, music and sound– isn't go-ing to make it."

"The story reel is the Word," Andrew Stanton concurred. "It's always a race to get the story reels to the degree that we like them prior to the big machine of making the movie."

Supervising film editor Lee Unkrich worked closely with the story department to edit the storyboards, then helped shape and integrate the scratch dialogue, sound effects and temp music into the story reel. Before the actual animation could proceed, the story reel dialogue was replaced by the final recorded voice talent tracks. "The actors gave us wonderful material," Unkrich observed, "but we still had to find the rhythms and interplay of dialogue. We had to create the illusion that all of these actors, who were usually recorded separately, were performing together. We were also looking for those spontaneous moments when something magical came out of the actors' mouths. It was an evolv- ing process."

While the conceptual work was forging ahead, the technological groundwork was also being laid. Supervising technical directors Bill Reeves and Eben Ostby led a preproduction technical team which considered issues from computer power to model building. "Preproduction on Toy Story was a case of 'Oh my God, how are we going to do a seventy-five-minute movie versus a four-minute short?'" Reeves said. "On Toy Story, we were taking the technology we'd developed in the short films and commercials and running with it. While we reinvented some of that infrastructure for A Bug's Life, the real push in preproduction was figuring out how we could make this film richer. The organic nature of this movie came out of the world of our insect characters. I suppose we could have told the story in a kitchen, but John got really excited about the look of miniature photography– the whole 'small is big' thing. We got caught up in wanting to show that world."

The technical direction team knew Lasseter also did not want a static world, but one full of natural movement, with a feeling of wind blowing through the trees and fields. Procedural tools, which had also been available on Toy Story, were accessible through Marionette and allowed the computer to randomly lay out entire environments. But unlike the geometric, human-built places of Toy Story, the tools had to create a sprawling, organic world. "We wanted a subtle sense of movement," Reeves explained, "but we didn't want animators having to animate every blade of grass. So we came up with a system whereby models of different vegetation could be built and set-dressed and made to move in procedural ways. This system still allowed high-level control."

The building blocks of Ant Island began with a two-foot-square plasticine sculpture created by production designer Bill Cone, which was scanned with a Polhemus digitizing stylus and in-

house software. The resulting database was then tweaked and sculpted, with other features of the environment – such as the old tree– created in Alias. “It was an iterative process of going from something fairly coarse to something quite detailed,” remarked Eben Ostby, whose emphasis was on the modeling. Once the modeling on Ant Island was completed, shading work was done to blend the anthill with the surrounding riverbank. “The cracked mud of the dry riverbed was built in our procedural system with data created in Alias. The design had pads of mud with spaces between them. The shader people went in and made them look so good we could get the camera close up, which was astounding. I’d originally felt we’d only be able to look at this landscape from a distance.”

The look of A Bug’s Life benefited from Pixar’s extensive explorations into the insect world, with the whole team becoming amateur entomologists. Helping the team as they trolled through countryside and underbrush was ‘Bugcam,’ a tiny video camera attached to a pole, which revealed the wonderful secrets underfoot. “The thing that most surprised and inspired us was how almost everything at insect level is translucent,” Lasseter recalled. “Imagine being in a world where all the buildings are created of stained glass– that’s what the in-sect world is like.”

Capturing that vibrant, stained-glass look required an overhaul of Pixar’s shading and lighting tools. New tools, written into the venerable RenderMan shading language, included procedural effects for translucency, backlighting and rim lighting, as well as support for a full-blown, highly detailed 3-D painting system. The defining moment for the production’s illumination model was the ‘leaf bridge’ test, a scene featuring ants crossing a leaf lit with a luminous glow. “We had to create the iridescence and translucency you get when you zoom down into the insect world,” explained technical produc- tion supervisor Graham Walters. “We knew the shad- ing and lighting effects we wanted on A Bug’s Life couldn’t be accomplished with Toy Story tools.”

Shading supervisor Rick Sayre, director of photography Sharon Calahan and tools engineer Lisa Forssell worked for about a year to fundamentally reinvent the shading and lighting calculations performed by the renderer. “The translucency issue involved the shaders and lighting interacting,” related Calahan. “One of the major differences from Toy Story is that in this film surfaces and lights understand each other and can communicate. For example, we had backlighting controls so the surfaces would accept that kind of light and react to it. The illumination model helped determine the finished characteristics, such as how glossy or satiny a surface was, all the textures and displacements, the color and lights.”

Sayre’s research into the shading possibilities included poring through scholarly papers on illumination models for realistically simulating how light gets trapped on a surface. “But we didn’t have a slavish devotion to what might be physically correct,” Sayre insisted. “Instead, we boiled down the large number of parameters you have on a surface into knobs– our term for controls– that were relatively intuitive and user-friendly.” Even if a surface was shaded with a procedural shader as opposed to a painted one, paintings were used to influence the procedural aspect to make it look more organic and less algorithmic. “The painter could get in and tweak things, which helped provide a visual richness. Something could be procedural, but it didn’t stand out as being procedural.” The procedural system also allowed layers of 3-D paint to be combined in complex ways that would mimic the randomness of nature. “It’s like all these digital paintings were thrown in a bucket and the shader was able to rummage around and pull

out and interpret whatever layer was appropriate. Through the shader, a lot of detail could be added that wasn't in the model– it was modeling after the fact."

Sophisticated shaders allowed for variations of a single model. For example, outside of some hero rocks there were only three or four rock models used throughout the movie. And instead of modelers having to construct an entire leaf– which at closeup scale required filigree along the edges and other elaborate detailing– painters could take a rough leaf model and use the shading tools to finesse the final shape. "Something that would be insane to do geometrically was done in shading," Sayre explained. "The set dressing department could throw down a hundred leaves and none of them would look the same. The painters could indicate to the shaders where they wanted the veins to be, or how the shader should respond to light from behind to achieve the translucency that's so much a part of this world."

The enhanced shading and lighting systems produced amazingly complete and detailed virtual environments for the production to explore during the transition from 2-D story reels to layout, the stage for set dressing and camera work. That exploration was literal, with 'location scouts' being conducted by members of the layout team who took the virtual camera into the 3-D environments several days prior to the actual layout work. Those initial explorations isolated and honed in on interesting angles and places within the virtual setting. "When you're splattering procedural treatment all over a large prop like the tree or riverbed," noted Keith Olenick, "sometimes the camera will reveal things to the modeler or shader writer they did not even know was there! So we had location scouts go into this world; and based on what they found – perhaps a neat little angle behind the root on Ant Island– the set dressers would then prepare it for shooting."

"In layout, something in the far distance might look so interesting that we'd want to bring our camera right over to it," added Eben Ostby. "Rick Sayre made the point that the only person who makes films the way we do is James Cameron. On Titanic he built almost the whole ship– just in case he needed to get down behind the broken dishes. On this film we built a lot of things that were behind the broken dishes."

Modeling was another area in which Pixar advanced its ambitious production agenda. While Toy Story had concentrated the most complex modeling controls on Woody and Buzz, even the supporting cast members of A Bug's Life were at the complexity of the Toy Story stars. "The best way to compare the modeling leap from Toy Story to this film is to look at the time we spent building the characters," observed Ostby. "Almost all of our characters in this film were like Buzz and Woody, what we call 'three-month' models– which is how long they took to build. Also, in Toy Story only Buzz and Woody were given the full suite of facial animation controls for things like mouth and eye shapes or the way cheeks could puff out. On this film, except for a few minor characters, all the models had the same rich set of facial controls."

Building the bug cast generally involved digitizing physically sculpted heads and affixing them to bodies built in Alias and imported into Marionette. "We love our animation system because it's a completely open system that we have total control of," commented Ostby. "We can extend it or import things into it. We do a lot of stuff that way because there's no point in reengineering a good modeler like Alias." An important surface modeling tool for A Bug's Life was subdivision

surface technology, which allowed Pixar modelers fine control, particularly in the facial area, enabling them to create detailed mouth movements while retaining smoothness in the cheek area, for example. Although subdivision surface technology had been around for decades– Pixar's own Ed Catmull wrote a paper on it back in the seventies– the technology had only recently been developed at Pixar.

Co-director Andrew Stanton and director John Lasseter pose with sculpted maquettes created for their principal bug characters. Innovative modeling and animation techniques, coupled with advances in shading and lighting, were instrumental in realizing the film.

For a decade, the optimal way to model dimensional surfaces had been through 'non-uniform rational b-splines' or 'NURBS,' a system that was problematic when it came to the sort of fine control needed for a production like A Bug's Life. "The downside of NURBS is that they're restricted to a certain topology," Bill Reeves explained. "NURBS need to have four sides to them, like a little sheet of paper. Although you can blend them together in full complexity and hide any seams, it's not convenient if you want a topology that's three- or six-sided. Another thing you have to worry about with NURBS is them bunching up, resulting in folds and deformations. Subdivision surface technology is a new way of looking at how to build a dimensional surface. You don't have this four-sided topological restriction. You can essentially subdivide surfaces, hence the name. And the more you subdivide, the smoother a surface you can create."

Flik sets out to find warrior bugs to defend the colony and soon finds himself in a veritable city of food containers teeming with insects.

The animation began with a thirty-person team which, in the ramped-up spirit of the production, doubled across the span of twenty-six sequences. Pixar had set the standard for the methodology of attacking an all-computer animated feature on Toy Story, and the company continued its philosophy of sharing character work among the entire animation team for A Bug's Life. "In traditional animation, people tend to be assigned a particular character," explained Rich Quade, who supervised the animation with Glenn McQueen, "so you'd have the 'Flik Team' or the 'Hopper Team.' But early on during Toy Story, there was this idea that to keep things fresh we should give a variety of characters to the animators. So on A Bug's Life we might have someone mostly doing Flik, but they would also have a lot of Manny shots. In the end, we might have as many as forty different people animating Flik. That would be a major problem

Flik sets out to find warrior bugs to defend the colony and soon finds himself in a veritable city of food containers teeming with insects.

with traditional animation because it would be difficult to keep characters on-model, maintaining a consistent look. But the big advantage computer animation, even stop-motion, has over traditional animation is that the look of a character will be the same, no matter how many different people animate it." Animation consistency was also helped by small teams of four animators handling the earliest shots of a character, establishing the persona and setting the standard for other animators to follow during the subsequent two-and-a-half-year production odyssey. Morning dailies were also a venue during which John Lasseter, Andrew Stanton, the supervising animators and the artists themselves could critically evalu-ate animation and check for consistency.

The richness of all the character models and environments was enhanced by new lighting tools. Back on Toy Story, the virtual lighting effects were a pale imitation of the rich lighting palette of A Bug's Life. But as with the virtual camera, the unbounded possibilities of lighting were reined in to emulate, not shatter, the conventions of live-action. "Whether people think about it or not, there's a whole visual vocabulary they're used to when they watch a movie," remarked Stanton. "So we adapt the camera language of live-action, which makes the audience recognize, probably unconsciously, that this is a real movie."

Lighting effects were also vital for establishing what Pixar called 'eye fix,' the art of drawing the audience's attention to a particular piece of action. "Even though it's a phenomenally detailed movie, we know what we want the audience to be looking at from a story standpoint," Lasseter commented. "It's very subtle; but every shot, cut, camera move and lighting setup draws your eye where we want it to go."

"Our mantra in lighting is that the action reads visually and the audience sees what it's supposed to be seeing," Sharon Calahan agreed. "Once we achieved that, we could work on making it pretty and seeing that it cut well with the shots around it. Readability, beauty and continuity– those were the three things we were always trying to maintain. In the process, we'd light a key frame for an extreme camera angle or character pose and do a test where we would render everything in-between to see how it looked. We might catch some motion we had not accounted for– perhaps a hand gesture or facial expression– and we'd highlight that to make sure the action would read."

Calahan was particularly concerned with how light and camera moves made a scene read when played out across the CinemaScope expanses. "We wanted everything to look rich, so the landscapes were fully textured, with wind blowing through the grass," Calahan commented. "But then, once we had that complexity, we tried to reduce things, to make the images visually simple so that the shot would read better. That was particularly important in crowd scenes or where there were lots of busy vegetation textures."

In some cases, making specific action read was a matter of lens choices. "We used depth of field a lot," Calahan noted. "If there were two foreground characters set against a busy background, we'd knock the background out of focus, just like a normal camera lens would do. But the idea was to go for believability rather than absolute realism. We would throw logic and realism out

the window if they were interfering with the believability of a shot. Audiences probably won't notice if something is frontlit when maybe it should be backlit; but they'll be disturbed if a scene doesn't read. We were trying to go beyond reality, yet still make something that wasn't a total fantasy world that would pop you out of the story."

The advancement of Pixar's lighting and shad-ing tools allowed for such dramatic moments as Hopper standing in front of a wall of fire, making the villain look like he was straight out of hell. But the lighting also conveyed subtle moods throughout the film, particularly in the vast underground chambers of Ant Island. Among the subterranean lighting sources were elegant, phosphorescent mushrooms designed like Tiffany lamps. "Each of the chambers had a different color for the mushrooms," Calahan noted, "depending on the mood of the scene. The scariest sequence is when the grasshoppers invade the colony; so we picked blue mushrooms to make the atmosphere feel cold and threatening." For a scene in the council chamber in which the artists wanted to convey an institutional feeling, the environment was diffused with soft green light.

At one juncture in the production schedule, the techno-gods seemed to conspire against the team's ambitions as the complexity of the models hindered the animation and reduced progress to a crawl. The rendering system also ran out of steam, with some frames taking as long as ninety hours to complete. "It was something we didn't see coming," Graham Walters admitted. "We were pushing the envelope and hit an unexpected hurdle with our software. The system had worked on Toy Story because toys have a lot of rigidity to them; but on this movie the characters needed to be very organic. Also, the average shot in Toy Story had two or three characters. In this movie, the average shot had five or six. The most complicated character shot in Toy Story had twenty humans in the Pizza Planet sequence. In the insect city of this movie, we were animating about 196 individual bugs– not to mention all the crowd shots with upwards of one thousand ants per shot."

"This was the only real crisis of this show," producer Darla Anderson added. "At the rate we were going, we wouldn't have been able to deliver the movie, no matter how many machines we bought." Anderson went to Pixar's executive offices and consulted with the likes of CEO Steve Jobs, production vice president Sarah McArthur and executive vice presidents Ed Catmull and Lawrence Levy. Anderson and the production requested, and got, permission to allocate in-house brain power to solve the problems and optimize the systems, assembling a rescue team that included personnel from the RenderMan department and Toy Story 2, the sequel slated for theatrical release in 1999. "One of the ways we optimized the animation," remarked Walters, "was to create low-rez versions of everything so the animators could get multiple characters on the screen. We also optimized RenderMan and made our Marionette system ten, twenty, even eighty times faster for specific things."

"Because of the complexity of this film, we were always looking for faster results," Andrew Stanton elaborated, "which is why we used procedural tools, letting the computer do things so the animators wouldn't have to. It was also common sense for the directors and the animators to decide at the outset what a shot was about. If there were ten characters, but the focus was really on two of them, we would concentrate on those two characters. It was about getting

priorities straight. It also made us better directors because it forced us, on every level, to consider why a shot was there and what we wanted out of it."

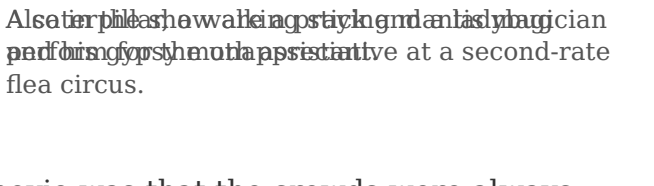
One of the major challenges was not only animating the large cast of individual character models but the massive Ant Island population. To handle the 430 crowd shots, and not overload the system, each department along the pipeline had to replace crowds with low-resolution ants. The crowd simulator itself required a separate team to create the layouts, animate and apply the multitudes of ants. "Crowds were something the story called for but weren't easily handled by the standard hero animation mechanism," Reeves commented. "A certain amount of procedural control was required."

The crowd team was composed of animators, led by Dale McBeath, and technical directors overseen by supervising technical director Michael Fong. The crowd simulator created for the show was an example of a Pixar hybrid technique, combining the calculating functions of a computer with the grand designs of individual animators. The resulting 'Fred' simulator code– just a funny name, not an acronym– was written principally by Bill Reeves and allowed the computer to assemble animation from a motion library, itself another leap from Toy Story. The library stored everything from lip syncs to individual poses and motion cycles accessible for crowd scenes. The fusion of animated library resources and procedural applications represented the best of both worlds. "People have used these techniques in 2-D, such as Disney did in The Hunchback of Notre Dame, where they actually used the same picture over and over again," noted Graham Walters. "The cool thing about Fred is that it really knows what's going on in 3-D. It can use the same libraries over and over with random variations that you don't really notice because it might be applied to ants of different sizes who are being seen from different angles."

The crowd technical team could load into Fred computed paths for each ant, along with barriers and collision avoidance controls. Then Fred would take over, applying the actual animation accessed from the library. "The crowd TDs handled the global picture," stated Michael Fong, "and the animators essentially handled the micro picture. It's scary how much of this was animating blind. We'd be taking snippets of animation and applying them everywhere, but we couldn't really see what the heck we were doing. We had a conga line scene, for example. We used Fred to apply the animation and hoped the characters were traveling in the appropriate lines. Having them interact with each other was another problem. We would render out a low-rez version and check to see if we were close to our goal. There was a level at which we could then bring in a real animator to tweak things individually."

Sometimes the complexity of a shot– such as a scene of ants sitting and standing underground on the roots of the Ant Island tree– made it too difficult to leave the animation application to the computer. The root was so twisty that TD Michael Lorenzen had to tweak the placement of many of the individual ants and tweak some of the applied animation once Fred was done. But the codes within the Fred simulator addressed a multitude of

challenges. One of its subtle aspects was the ability to give characters solid contact with the organic surfaces. “It was pretty easy to have Buzz and Woody walk across a flat plane,” Reeves remarked, “but one of the global challenges of this movie was that the crowds were always walking on these undulating organic surfaces. That part of Fred was automatic. If an ant was walking up a hill, its feet wouldn’t go through, but always be in contact with the ground. We could even get the ants to automatically lean into the hill.”


Also in the show is a walking stick named Slim, a magician and his assistant.

Just as crowds were handled separately, effects shots were relegated to a special team of technical directors. The final face-off between the grasshoppers and the ants, for example, was an apocalyptic sequence of fire and water. The fire was stirred up during the burning of a fake bird constructed of leaves the ants have hoisted into a tree in hopes of scaring off Hopper, and which is accidentally set aflame by the bumbling circus ringleader P.T. Flea. Then comes a sudden rain storm that hits Ant Island with hurricane force.

While the fire was created by the animators, the resulting smoke utilized effects from Pixar’s digital backlot, including the rocket exhaust trail from the Toy Story chase sequence. “Basically they were a collection of transparent spheres whose motion was governed by what we call ‘coherent noise,’ meaning they behave randomly,” noted effects TD Mark Henne. “Stacking up ten of these transparent spheres into a column provided the noisy appearance that translated as smoke as they visually interfered with each other. In shading we softened the shapes. I used the same smoke model for the dust that rises when the fake bird crashes, just changing the color to match the ground.”

While the backlot provided A Bug’s Life with a library of props from Toy Story– with the new film even benefiting from such in-joke placements as the Pizza Planet truck– it was subjected to the same upgrading as all the other tools and methodologies. “From the time A Bug’s Life started to the end,” remarked Reeves, “there were at least ten revisions of our Marionette system. Consequently, the backlot became out of date. We couldn’t just copy a file and run with it because something, somewhere had changed. So there was a certain amount of transformation needed to bring the old models up to date. Still, it was great to have the backlot there to start from. We just had to dust these things off a bit”

A rain simulator was written by Dan Herman for the storm climax. “For the water, we wanted a hybrid system that could simulate things, yet which we could also control,” Reeves said. “There were hero splashes we wanted to be very specific about; but then there might be ten thousand raindrops in a frame that the system would automatically place for us.” As developed, the rain simulator defined water behavior, surface properties and the like. “The software allowed for the hero splashes to be specifically laid down in terms of direction and target location,” Henne remarked. “There were a number of controls on how many particles were utilized in the simulation of a drop flying apart, the trajectory and force of gravity. There were a lot of parameters guiding the physics of the water.”

Taking it into RenderMan, Tom Duff worked on rendering the water through ‘implicit surfaces,’ an old CG technique. “The classic example is if you want to animate two spheres together,

implicit surface considers the sum total of both spheres and blends them together," Graham Walters explained. "So if you had a couple hundred of these spheres coming together and hitting the ground and going in different directions it would emulate the viscosity of water. Actually, we were going to try to do the water another way, but the RenderMan team kept working on the implicit surface approach. I have to give them credit– they saved our butts. They pursued it because they thought we'd need it– and they were right."

The power source throughout the production was the air-chilled room of computer processors known as the RenderFarm. The RenderFarm concept, also utilized on Toy Story, was that instead of an animator or technical director using his or her own computer to render images, that work could be off-loaded from the animation workstation and sent across the in-house network for rendering, freeing the artist to move on to the next shot. The upgraded RenderFarm featured ninety-six Sun E-4000 computers– eighty-four of which were used for A Bug's Life, with the others allocated to Toy Story 2– each of which is the power equivalent of one of the once-awesome Cray super computers. The whole enterprise ran twenty-four hours a day, seven days a week, all year round. So much heat was generated that if the air conditioning somehow broke down, the room temperature would have soared to 110 degrees within a half hour.

Another crucial element of the infrastructure was the DiskFarm, which provided roughly 1.06 terabytes of disk space. (A terabyte is a thousand gigabytes– equivalent to some 1700 PCs' worth of disk space.) The DiskFarm was used to store all the rendered images as they came off the RenderFarm. For A Bug's Life, the entire processing infrastructure was upgraded by Greg Brandeau, director of information systems. Even the RenderFarm itself was transformed, from a 'hub' network, in which every computer plugged into the hub sees all data traffic flowing by, to a 'switch' network. "A switch network is more efficient because it directs to you only the traffic you care about," commented information systems manager Duncan Keefe. "In addition to the network, we upgraded the servers and a lot of the animators' desktop machines, and put in a new backup system. It was a massive amount of technological investment."

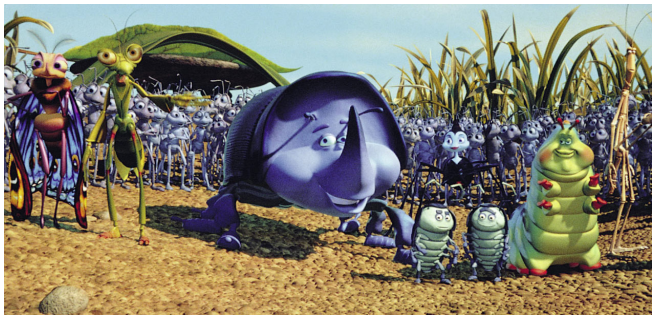
Lee Unkrich's editorial department also benefited from ramped-up technology. On Toy Story, the editorial process required a shot to be put on videotape and delivered to editorial, where it was logged-in and digitized into an Avid machine, with the edited results going back onto tape to be circulated. The editorial lifesaver for A Bug's Life was a new Avid tool called Open Media Framework Interchange. From the preproduction story reels to the shots in progress, both visuals and audio became digital data from the start. "We took this OMF tool – all its rules and specs– into Pixar's custom production software suite," said editorial supervisor Bill Kinder, "and allowed each department creating shots to deliver them in this interchange format and vice versa. Apart from the speed gained because we did not have to log, record and digitize tapes, there was also a quality gain because we didn't get a lot of the compression artifacts that come with analog videotape."

One of the big advantages of the OMF editorial system was the ability to track each shot through all its iterations. It was a staggering number since after multiplying the final count of 1636 shots by an average of six takes through five departments there was a minimum of fifty thousand deliveries of individual shots throughout the production phase. But with OMF, those shots could be called up on monitors and were instantly identifiable by number codes indicating shot and sequence, even specific frames. Color codes also identified specific departments and production status, from rough 'red' versions, to 'yellow' for shots still requiring work, to a final 'green' status coding. "The system is insanely complex," Kinder conceded, "but what's great about working at Pixar is these problems can be solved. Orson Welles once said making movies was like the ultimate train set; and here at Pixar are the best hobbyists and the coolest, fastest train set you could ever play with."

Not just the bug characters, but every visual element in the film had to be created digitally. On the scenic level, particular emphasis was paid to reproducing the sense of translucency evident in microscopic photography. Art director Tia Kratter works on leaf concepts.

Evidence of the artistic and technological leap from Toy Story to A Bug's Life can be seen in a comparison of each film's first completed scenes. On Toy Story, the kick-off sequence was the toy soldiers leaving Andy's bedroom and setting up a reconnaissance mission in the hallway planter. For A Bug's Life, it was the 'flaming death' matchstick scene in the circus, a madcap sequence full of complex characters, lighting and action. "It's almost sad how, after first seeing that circus sequence, we got used to the look of this film," Stanton mused. "It was so good. At the time we called it 'painterly.' It's a look both photoreal and illustrative. In computer animation, the look is always going to be photoreal because you're creating lights, shadows and reflections that seem to follow the laws of physics. But this movie also allowed us to get into the artistic side, particularly with lighting."

Returning to the colony, Flik makes a grand entrance with the circus troupe.



A new library-based system for animating and rendering crowd scenes was developed for the film.

For A Bug's Life, the visual domain of the third reality– that combination of photorealism and artistic stylization– had been allowed to evolve over a span of four years. But the world of compu-ter animation is accelerating, and those multi-

year schedules might someday seem as leisurely as sea cruises compared to the supersonic flight of future film productions. Pixar has upped the ante itself, announcing in its 1997 annual report a goal of theatrically releasing a computer animated feature each of the next three years. Meanwhile, the partnership with Disney has bloomed, with a 1997 deal making the two equal partners in a plan to release five films over the next decade.

No less an authority than Disney CEO Michael Eisner has suggested that computer animation will be the ultimate storytelling medium in the 21st century. Yet John Lasseter, for one, is not convinced that the 3-D realm will ever replace traditional cel animation. “Look at Mulan,” Lasseter reflected. “It was inspired by Chinese painting and line work, and that style is so beautiful in the hand-drawn medium. People once said photography was going to replace painting– and of course it hasn’t. How can a camera replace Monet or Picasso?”

Still, Lasseter and all of the key players at Pixar recognize that computer animation will continue to evolve. “Along with increased computer power and memory, complexity will increase,” Lasseter asserted. “The last sequence we did in Toy Story, the chase sequence through a neighborhood, was the most complex in the entire movie. But the first sequence we did in A Bug’s Life, the circus scene, was a leap beyond that chase sequence. The shots on this movie were so huge that even with our giant RenderFarm they were just crashing everything we had. But that’s typical of Pixar– we’ll always need five or ten times the memory we’ve got. It’s not so we can say, ‘Look how complex this is!’ We’re just making it part of the story. It’s there to see on the screen. That’s why, for A Bug’s Life, we coined that funny little phrase, ‘an epic of miniature proportions.’ Because this is truly an epic film, comparable to the scale of Ben-Hur– except it was all done in the computer.”

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VIRUS
BUILDING A BETTER BORG

article by Kevin H. Martin

The notion of ‘Man as virus’ has antecedents in the horror genre dating back to I Am Legend, a Richard Matheson novel loosely adapted to film in The Last Man on Earth and The Omega Man. In that apocalyptic tale, a race of plague-transformed vampires is in the process of becoming the dominant form of life on earth, but its members still fear the sole surviving Homo sapiens– just as man himself once dreaded the Red Death– seeing his continued presence as some awful and virulent disease visited upon their kind.

In Virus, directed by John Bruno for Universal Pictures and Mutual Film Company, a noncorporeal extraterrestrial intelligence manifests itself aboard a Russian science ship in stormy waters. This electrically-based lifeform inhabits the vessel’s mainframe computer, directing onboard robots to build a succession of ever more sophisticated and deadly biomechanical constructs to do battle against the human virus struggling to prevail against it. Dark Horse Comics, a publisher of graphic novels featuring a particularly strong cinematic bent, issued the Chuck Pfarrer story– principally set on a Chinese ship and pitting the crew of tugboat Electra against the mysterious and powerful alien force– as a four-part series beginning December 1992.

Less than three years later, visual effects artist John Bruno– after helping Universal complete a difficult postproduction on Waterworld and going on to co-direct portions of their T2/3D theme park extravaganza– was on the verge of accepting an effects supervisory position on James Cameron’s Titanic when he was summoned by Universal chairman Casey Silver to discuss Virus. Silver offered Bruno the opportunity to direct the film, provided he also agree to serve as visual effects supervisor. “Discovering that Virus would be a Dark Horse production sparked my interest immediately,” Bruno recalled. “Mike Richardson, a longtime friend, was going to executive produce, and Gale Anne Hurd, a close friend since The Abyss days, was already attached as producer.” While the people involved appealed to Bruno, another aspect did not. “Virus certainly was not what I had envisioned for a first feature directing assignment. At that point the script strayed somewhat from the graphic novel, both in its complexity and variety of creature transmutations. Also, both the novel and the script took place on a Chinese vessel that was pure fiction. The lack of credibility really bothered me, because I knew the Chinese didn’t have the resources or the technology to float anything remotely approach-ing this.”

Shortly after this meeting, James Cameron and Bruno embarked on a deep-ocean dive to film the Titanic wreckage in preparation for Cameron's epic. While at work on the earliest stage of that movie's preproduction in Halifax, Nova Scotia, Bruno lived for a month aboard the Russian research vessel, Akademik Keldysh, made two dives to the Titanic, experienced Hurricane Louis firsthand– and considered his options. "Soon it came down to one question," Bruno said. "Was I going to work for Jim or direct Virus? Jim said that when a studio head offers you a major motion picture, you say, 'Yes.' I told him about my script qualms and he was very straightforward: if the story wasn't to my liking, I should make it my own and bring my real-life experiences to it." Bruno took a new look at the script, this time drawing on his experiences aboard the Keldysh to enrich the storyline. These changes helped embellish design and plot elements while enhancing plausibility. "I began gravitating toward the idea of this ship being of Russian origin. Seeing and experiencing Hurricane Louis up close gave me the idea of using a heavy storm as a second threat, apart from the extraterrestrial entity." Aboard the Russian vessel, Bruno had observed a scientist performing atmospheric tests by firing a green laser up to the Mir space station as it passed overhead, inspiring him to rework the screenplay's opening. "Mir would be transmitting data to the science ship as this electrical entity smashed into the station, causing some or all of the alien to be caught in the data stream and transported to earth, entering the ship's mainframe."

An alien electrical entity strikes a space station and is relayed to a Russian research vessel below in the John Bruno sci-fi horror film, Virus. Model elements by Fantasy II were supplied to VisionArt for animation enhancement and compositing.

Bruno proposed the story changes to Universal, securing approval for a new screenplay draft that also addressed the issue of communication between creature and human– a non-issue in the graphic novel where the titular virus referred to the extraterrestrial force's inhabitation of the mainframe, like a traditional computer virus. Script revisions by Dennis Feldman and Jonathan Hensleigh introduced the notion of Man as virus, adding an intellectual element to the premise.

Seeking refuge from a raging typhoon, the crew of an ocean tug discovers the Russian ship, adrift and apparently abandoned, in the placid eye of the storm. Wide shots were created by Cinesite.

To bring his Virus to life, Bruno required the services of a number of effects facilities. VisionArt Design & Animation provided luminescent character animation effects; Acme Models– in one of its final assignments prior to becoming Cinema Production Services– built key miniatures seen in the opening and at the movie's climax;

Cinesite Hollywood created a massive storm wall synthetically; and Fantasy II modified and built seagoing models while constructing a massive tank facility in which to film them. On the creature end, Steve Johnson's XFX created an array of tiny droids and man-sized biomechanoids. These served the needs of a twelve-foot-tall mechanical monster called Goliath, the electrical entity given form by All Effects and put into motion digitally by Tippett Studio. The organization and scheduling of this massive effort were entrusted to Lori Nelson, Bruno's hand-picked co-supervisor who then enlisted the aid of visual effects producer Michelle Villello.

The movie begins aboard the space event ship Akademik Vladislav Volkov, a research vessel cruising the South Pacific. Virus author and ex-Navy SEAL Chuck Pfarrer found a life-sized stand-in for the Volkov– a 'nuclear-powered haunted house,' as one character in the comic describes it– on the James River, south of Norfolk, Virginia. "There were several World War II Navy ships that were going to be scrapped," Bruno explained, "and Chuck and I went to scout one of them, a missile tracking ship, with three big satellite dishes, called the Redstone. As it turned out, the Redstone had already been scrapped, but a sister ship, the Hoyt S. Vandenberg, was still there, awaiting the same fate. We had to enlist the help of Senator John Warner of Virginia to gain the ship's release; and, ultimately, we were able to lease it from the Navy for one dollar." Converting the Vandenberg into the Volkov was a four-month-long process. "I wanted to use the ship's real lighting fixtures, so we had to get it fired up to utilize the on-board generators. Our production designer, May-Ling Cheng, built a thirty-foot extension onto the bridge of the ship– using a combination of steel bracing and wood– which effectively doubled the size of the bridge." Working from the director's video reference, Cheng devised a paint scheme that worked stylistically for the film while also appearing suitably Russian.

Since the Vandenberg could not be restored in her entirety to the pristine state mandated by the story– only half of the ship was painted– a miniature replica was required for long shots as well as storm scenes. Having acquired his full-sized craft fairly painlessly, Bruno fully expected that finding a model to represent the Volkov would be an equally straightforward matter. Aware that the forty-two-foot, twin-hulled Benthic Explorer model from The Abyss– a film for which Bruno had supervised the effects– was an appropriately-sized, proven and seaworthy miniature, Bruno determined to track it down and purchase it. "We traced the Benthic to Valencia, California," Bruno recalled, "and found that the hulls were lying out in an open field. But Virus wasn't a 'go' yet, so the studio refused to purchase them. I told them they'd save half a million dollars by investing a couple thousand– money that could be recouped by selling the Benthic off again if the picture didn't happen. They continued to stall, so I just laid down four grand in cash and bought them myself."

The studio later reimbursed Bruno for the hulls, which were transported to Fantasy II, where they underwent modification and substantial embellishment. "To create the forty-seven-foot-long Volkov," stated Fantasy II effects supervisor Gene Warren, "we wound up having to add three feet to the bow and another two feet onto the stern of one Benthic hull." The miniature– roughly eleventh-scale– was fashioned using nontraditional methods, with a superstructure consisting principally of welded aluminum, augmented by copper and steel. Rivet detailing was cast from a bondo-resin mix. "In order for the rivets to adhere to the welded aluminum, we needed a special alloy; and keeping the bondo thin in proportion to the amount of resin used

gave that to us. That model had to be capable of taking all the abuse we were so good at delivering, so we built it tough." Thirteen marine batteries were required to power the 180 exterior lights on the Volkov, creating a self-illuminating 'oil rig at night' look. The model was transported out to sea, then deployed from a barge near Paradise Cove, where the film's opening daytime shots and numerous pre-storm views were captured.

The action shifts to earth orbit, with a mysterious energy force fast approaching space station Mir. Working from photos provided by technical consultant Dr. Norman Thagard– who spent four months living aboard Mir– the Jet Propulsion Lab and NASA, Mike Joyce's Acme Models constructed a seven-foot-long Mir space station miniature covered by a cotton-like textile resembling material used on the exterior of the real Mir. Acid-etched brass was utilized to duplicate the gold-colored filigree overlaying Mir's blue-backed solar power arrays. These panels, like the nuclear pod and various antennae extending off the main body, were detachable, allowing the model to be transported safely. Fantasy II photographed the Mir in Vistavision format, then passed the footage on to VisionArt for compositing with their electrical energy entity and earth/starfield background. "Someone had built an earth miniature," said VisionArt effects supervisor Joshua Rose, "but it was not deemed sufficiently realistic. So we ordered aerial photographs from NASA, scanned them at 4K, then tiled them together to build our own earth surface. That was texture-mapped onto a 3-D surface, and we supplemented the NASA clouds with a digital cloud layer reveal-ing the storm conditions on the ocean below."

Upon boarding the Volkov, the tug crew finds that the noncorporeal alien has used the ship's physical resources– crew included– as building materials for a combat force of biomechanoids. Makeup and animatronics were by XFX.

VisionArt began work on the electrical-force-based alien form without benefit of a detailed design. "John mentioned liking the shockwave at the beginning of Star Trek VI," Rose noted. "That, plus knowing the organism was comprised of energy, gave us a starting point. John settled on a hybrid of two drawings made by our traditional pen-and-ink designer, Robert Tom, who worked with our 3-D department to make sure we'd be able to build the design. While possessing a geometry-defined form, the creature's structure throbbed and dissipated, suggesting inhalation and exhalation."

Steve Johnson– founder of XFX– examines one of his creations.

Animated by Todd Boyce, the Prisms-built entity contained layers of animated textures, with volumetric renderings of cloudlike atmosphere moving through and around it. The animation of these tendril forms helped to impart a greater sense of velocity to the entity's motion than its gross movement through frame could imply. The energy textures were created with Sparky, VisionArt's proprietary particle system software. Alette Vernon composited the sequence using Silicon Grail's Chalice. "We'd never tried it before," Rose remarked, "but Chalice ended up working well for us. Chuck Spalding at Silicon Grail gave us plenty of attention, supplying plug-ins or help whenever we needed something special to create a unique effect."

Both makeup and mechanics were used in depicting Captain Everton (Donald Sutherland) after he has been biomechanized and his head grafted onto another's body.

The alien entity smashes into the station, its arcing energy bolts penetrating Mir's hull, killing cosmonauts and playing havoc with the electrical systems. The lightning bolt effect was a separate Prisms project handled by lead animator Dan Naulin. "There was some interactive light shot on set," stated Rose, "but the actual arcs going through the station, tearing Mir apart, were all ours."

The space station interior was an exceptionally accurate representation of the real Mir, with few concessions made to audience expectations. "All the Mir monitors displayed real tape footage from space," Bruno declared. "But we did have to add some consoles, because on the real Mir, there are none. In reality, the crews mainly use PowerBooks now, strapping them onto the kind of steel shelv-ing you'd find in your home garage."

The entity enters Mir's earthbound radio transmission, racing down through the storm to Volkov on the seas below. A company that specializes in film trailers, Cimarron/Bacon/O'Brien, created the vertiginous plunge from orbit that had originally appeared in the Virus trailer. Upon viewing their shot– which was achieved by compositing a Fantasy II miniature element of the ship with digital clouds and water– Bruno had CBO render a high-rez version for inclusion in the finished film. The entity invades the Volkov through one of its satellite dishes, which blows apart from the sudden overload. Fantasy II shot the blast high-speed at between 92 and 160 frames per second.

Caught up in Typhoon Leiah, the tugboat Sea Star– in waters near the Volkov– is furiously pummeled by high waves. The remainder of the movie takes place aboard either the Sea Star or the Volkov, with a significant amount of screen time devoted to displays of extremely volatile

weather. A customized tank was crucial to the creation of such scenes. “Back on The Abyss,” Bruno noted, “Jim Cameron and I had talked with Gene Warren at Fantasy II about the possibility of building a tank that would be capable of generating a six- to eight-foot wave. The idea finally reached fruition with this project. The tank created swells taller than a man; and with wind machines, we could create some genuine storm conditions in there.”

Bruno and Warren first had to convince Universal that a big tank– built from scratch– was the way to go. Looking to save money, the studio suggested using its own Falls Lake backlot tank as an alternative; but since local noise and lighting abatements went into effect after ten o’clock each evening, the night-for-night shooting scheme would be effectively scotched. Yielding to the logic of the situation, Universal acceded to Bruno’s wishes, authorizing Fantasy II to commence construction on the new tank. “In the past there have been many pictures that could have benefited from a tank of this kind,” Gene Warren remarked, “but none of those shows had a sufficient number of shots to make building something this elaborate cost-effective. Because there were going to be sixty or seventy storm shots, Virus was one film that really did need a big tank. It was an effective, financially sound approach that also gave us the highest quality results.”

Warren built a twelfth-scale model of the tank and shot a series of tests. After each trial, the miniature prototype would be reworked. It was essential that the design, when scaled up for the full-sized tank, be structurally sound in order to withstand the rigors of water and shooting. “Another consideration,” Warren remarked, “was ensuring we could get the necessary camera angles while allowing for the plumbing and recycling arrangements. Once we’d locked into that, I started looking for a place to build it. It’s become harder and harder to find a place in L.A. to do fire work and noisy explosions, especially at night.” Warren eventually found a site for his tank in Sun Valley, between two junkyards and behind the local water-and-power’s recharge pits. “The closest residential area was miles away, so there weren’t any neighbors to disturb. We could shoot all night long and make as much noise as we wanted.”

Measuring more than a hundred feet in length and width, the tank easily accommodated even the huge Volkov. Featuring a U-shaped eight-foot shallow extending around three sides, the tank plunged to a depth of twenty-two feet before ramping back to twenty feet at the center. To create the enormous wave actions called for, a forty-foot-wide, twenty-eight-foot-high concrete tower was built and filled with water by two Rainmakers. The wave water was dumped through a tunnel four feet below the water line, via a mechanically-hinged, forty-foot-wide door. “It would have been nice to do this hydraulically,” Warren admitted, “but we could still crank the door shut with a cam, then hold it in place with a pelican hook. We managed to get five-foot waves, which looked huge, and there was the theoretical capacity for going as high as six or eight feet.” The system allowed for fast turnarounds, as up to six wave dumps could be staged in a single night.

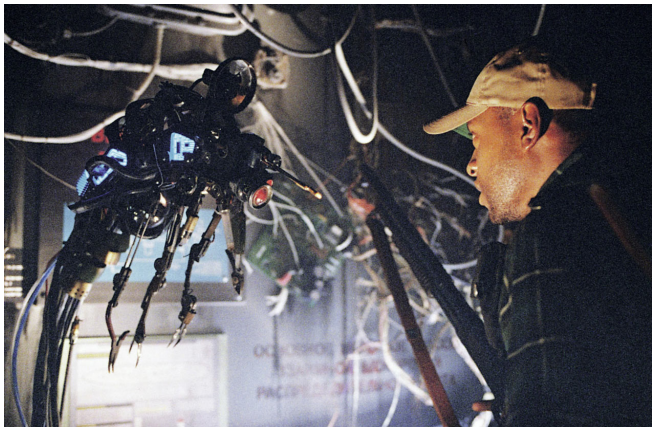
On the bridge of the storm-tossed Sea Star, navigator Kit Foster (Jamie Lee Curtis) tries to convince Captain Robert Everton (Donald Sutherland) to cut loose a heavy barge and make for safer waters. As Everton has invested his entire personal wealth in the uninsured cargo aboard the barge, he remains steadfastly resistant to Foster’s suggestion. Ship’s engineer Steve Baker (William Baldwin) sides with Foster, but they find themselves overruled by the captain’s

handgun. Foster's point is made when the barge breaks free and begins to sink. The tug is steered to a temporary safe haven– in the eye of the typhoon. The Sea Star bridge and other interior sets were filmed on stage at Screen Gems Studios in Wilmington, North Carolina. To recreate the necessary storm conditions on stage, May-Ling Cheng purchased key gimbal components left over from her previous film, Turbulence, then used them as the basis for Virus' custom gimbals.

Fantasy II built miniatures of both the Sea Star tug and its barge, fabricating aluminum support struts and exteriors over the vessels' steel-ribbed innards. The tugboat required five operational bilge pumps and was pulled through the water by cable. To generate the ship's wake, a jet-ski was installed and operated by Steve Cohen, inside the model, and towed by Daniel Deschamps from the shore. Three additional pumps were needed to keep the barge afloat. These permitted the Sun Valley unit to avoid costly crane rentals for the duration of the shoot, as both the barge and the Volkov could be simply left floating in the tank, tethered by steel tie-downs. "We used fifty half-inch steel plate boxes," Warren stated. "They were set into concrete and measured six inches on all sides, with steel rod anchoring the interiors. Very heavy rebar had been poured beneath the tank's gridwork, so you could attach a tie rope to any of these fifty points, which made the tank very user-friendly." Six tie-offs were needed to moor the Volkov model, with each line leading to tires placed along either side. "The tires acted like shock absorbers– and when you consider that a properly ballasted ship weighed about 36,000 pounds, they were really essential. Those lines stretched considerably when waves caused the ship to rise, but the miniatures didn't ever beach." Christopher Warren headed the camera crew and shot most of the ship tank footage. A combination of smoke and mist was sufficient to create the impression of a turbulent night sky.

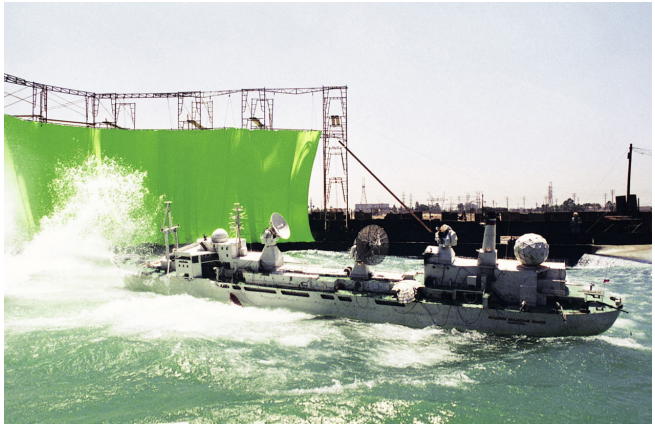
Investigating a sonar signal, Sea Star comes upon the fog-shrouded Volkov looming ominously. Everton sees the seemingly deserted craft as an opportunity to make up for his lost cargo, and enlists the aid of his crew in salvaging the huge ship, which he estimates will bring in seven-figure splits for all hands. But upon boarding the Volkov, the Sea Star crew soon comes to realize that something is still very wrong on the ship. The sole Russian survivor, science officer Nadia Vinogradova (Joanna Pacula), runs amuck with a machine gun, in wild fear of an extraterrestrial entity she claims has inhabited the computer system. When the Volkov's computer-controlled anchor is dropped through the Sea Star, sinking the tug– an impressive effect achieved live on location– the crew is marooned aboard the Volkov and soon finds that there is indeed an on-line aggressor.

“Upon entering the ship’s mainframe,” Bruno explained, “the creature read and absorbed all of the Volkov’s historical, geographical, biological and linguistic files. So the alien entity has become a genius on paper, but lacks practical knowledge. It orders the on-board robotics systems to build these incredible droid forms, working from the computer’s images of various creatures. Beginning with crab and spider forms, it equips the droids with video cameras in place of eyes, and a variety of mechanical substitutes for feelers.” To convey the notion of an automated droid-producing facility, Bruno rented an atomic arm– formerly used for cloud tank work– from Richard Edlund at Boss Film Studios, then leased fourteen robotic manufacturing arms from an industrial supplier. These practical robots were then programmed to per- form assembly-line functions.



Crew member Richie (Sherman Augustus) is menaced by one of the alien droids– realized in seemingly cobbled-together fashion by XFX.

Bruno turned to XFX for the design and construction of the small to human-sized droids, leaving the larger robots to the engineers at All Effects. “We agreed that putting all the robotics through just one house might not be a good idea,” Steve Johnson allowed. Early on, Johnson involved members of his crew in the creative end of the development process. “With each project, I try to come up with a different design approach to keep the work from getting stale. I didn’t want everything looking like it was from the mind of a single person; so all of us brainstormed together, determining which approaches would best serve the project while still looking different from the kinds of work we’d done before.” Brian Bero supervised the overall droid project for XFX, with animatronic design supervisor Eric Fielder responsible for engineering the mechanisms contained within each construct.



Fantasy II engineered and built a huge tank for miniature scenes of the Volkov– overtaken by the typhoon– being pounded by wind and waves.

Building several versions of each, XFX produced a total of sixteen different droids, ranging from six to twenty-four inches across. “We thought about what might be found on a ship like this and extrapolated,” Johnson explained. “A crab droid wound up with pliers for pincers, while the wasp droid– which evolved from a dragonfly in the comic book– sported legs made from hypodermic needles. We started with the machine-based droids. We created realistic-looking crab, lobster and rat pieces, then dressed the mechanical droid models with them– making it seem as though the droids have deliberately begun to incorporate living creatures into their makeup.” Some droids were rod puppets featuring few electronic parts, while others were radio-controlled free-walkers. “The umbilicals extending back from the droids to the mainframe

were entirely cosmetic. We went to all this trouble to make them free-walking, yet it was a story point that each had a cable plugged in at the back." Some droid shots used as many as thirty-five puppeteers, who would either be situated beneath the floor or hidden inside set walls. Mark Wilson led the puppeteering effort as droid motion coordinator, while Bud Smith shot the majority of the droid and robot work on the second unit.

The Sea Star survivors realize Typhoon Leiah has once more overtaken them, and that the Volkov is about to be swept from the relative safety of the storm's eye. At the Fantasy II facility, a thirty-five-foot greenscreen was erected in a cove along the curved back side of the tank to provide a matte area in shots depicting the ship in peril. The resulting plate element went to Cinesite Hollywood for compositing with a CG storm wall of their own creation. Cinesite visual effects supervisor Jay Riddle developed a look for the inner surface of the storm– a 35,000-foot wall of clouds churning in 130-knot winds and choppy seas within the eye of the storm. Bruno had provided high-speed wave plates filmed in Hawaii, from which a larger-scale wall could be built; but Riddle was concerned that using those elements would not ultimately provide the impact the shots deserved. "This sequence had tremendous scope," Riddle stated, "so establishing the proper scale of water was essential. We needed to create a water surface that extended from the Volkov bridge to several thousand feet away."

The view from the bridge starts with a quick tilt-down, moving from a distant high range of clouds to the churning ocean below. "There was no established point-of-view that would allow us to step far enough back and show the boat inside the eye of the hurricane," Riddle explained, "so our POV provided only a limited geographic view of the situation. Even so, it had to establish the scale of the wave and the degree of peril. That one shot told a whole lot of story. For the audience to comprehend the storm movement and our proximity to it, we had to show the progression of tonal ranges that would let them realize this wall is coming straight at us– not the best angle for demonstrating speed and scale. We started at the top with the most distant part of the sky, as sunlight played on far-off clouds. This was backed by mid-range clouds that were in shadow as part of the great water wall. Near the water it got a lot darker, with tones growing muted and contrast disappearing. By the end of the shot, the rain and mist were washing out all detail at water level."

Five shots featured the wave wall, all of which cut together to form a linear sequence. "The storm's progression being so great from one frame to the next presented a challenge," Riddle noted. "We had a large-scale object moving a great distance in a brief amount of time– brief because John wanted to keep the sequence moving right along. Animating large objects too quickly just makes them look small; so to suggest the idea of this speedy wall of water while still retaining the slow, ominous look, I turned to the sea spray coming off it. A gross lump of water doesn't look all that menacing, but when you see the fine spray being kicked around by 200-mile-per-hour winds, then it becomes dramatic. We wrote code allowing the software to recognize certain water movement conditions. When the normally choppy water got picked up in this seventy-foot swell, the system would identify the slope of the wave and generate sea spray particles coming off the swell in an appropriate scale."

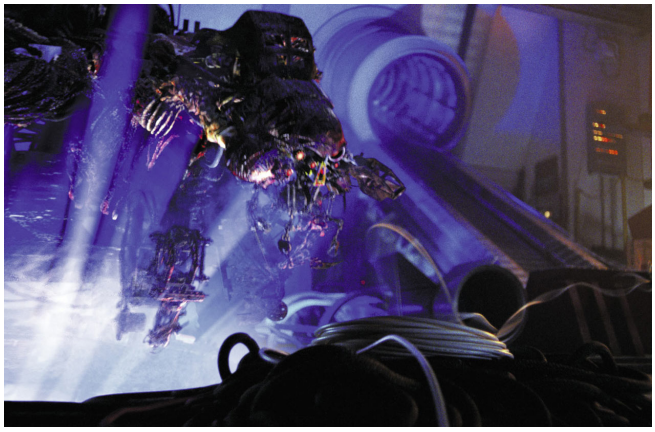
In addition to the violent spray, the look of the ocean waves dictated an upgrade from the established industry standard. "Cinesite had created a lot of water for Waterworld," said Riddle,

“but this time out, we needed to make significant software advances to further develop the movement of water. There were gusting winds even during clear conditions, and these required all the hydrodynamics you’d expect to see in choppy water. Fortunately, one of our key people on this project, Jerry Tessendorf, had helped architect the original Areté water software. He was able to modify that quite a bit, allowing us to generate water in ways the current standard package cannot.”

Riddle assembled a task force consisting of Tessendorf, Erik Krumery, Jamie Pilgrim and Alan Ruillova who, over the span of several months, refined and expanded upon the look of synthetic ocean while a separate team of artists handled a variety of digital fixes. “Much of the picture was shot in a harbor at Newport News,” Riddle related, “so land was often visible in the background. The paint department, led by Joe Dubs and Corinne Pooler, took out freeways, cranes and even some other boats– there were a lot of objects that obviously didn’t belong inside a hurricane in the South Pacific.” Roto work often took the form of horrendously difficult rig removals. “We received shots with giant cables that obscured both the actors and parts of the boat. They also crossed in front of turbulent water backgrounds. Normally you could just clone the water over the cables, but there was just enough of a pattern in these waves to keep us from being able to do it the easy way. Then there was the live-action on the bridge, shot with black behind the portholes instead of green. Some of those shots required us to generate subtle mattes in order to pull reflections from the window glass. Other times we’d just paint the ghosted images out before laying in our background.” In addition to marrying the wave elements and foreground plates involving actors, the Cinesite compositing team, led by Carole Ashley, changed the murky harbor water to something more appropriate for the open ocean.

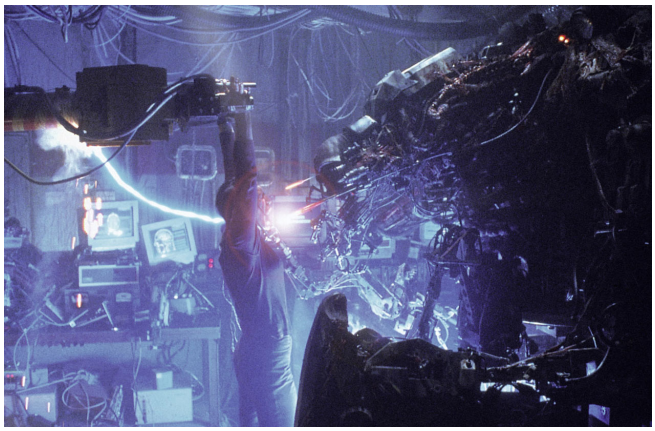
As if the raging storm and the small droids were not enough, the Sea Star crew is menaced by humanoid cybernetic forms– man-sized creatures which came to be called biomechanoids. “The creature tries to incorporate humans into larger forms,” Steve Johnson explained, “but its own electrical energy is far too powerful for the human body to withstand. So it decides to ‘improve’ them– first by killing just about everyone on board, then proceeding to combine their body parts with mechanical components.” Months before the picture was greenlighted, XFX conceptual designers Taishiro Kiya and Kerry Gammill began work on three different human-sized robots that, in the story, had to look as if they were made from the body parts of Volkov skipper Alexi, Sea Star engineer Squeaky Molleno and Captain Bob Everton. “Essentially, the three transformed characters represent separate approaches to realizing the robots. Alexi was pure robot, Squeaky was mostly makeup and Captain Everton was a combination of the two. We took a European approach to the robots, making them hyper-detailed, with layer upon layer of filigree.”

The first biomechanoid to be seen is BioAlexi, the energy creature's attempt to reanimate the Volkov's unfortunate skipper. "We built BioAlexi with triple-jointed legs you could see through," Johnson related. "There was no possibility anyone could think this was a man in a suit. Scott Patton oversaw BioAlexi in both of his incarnations, as stunt robot and as a hydraulically driven one capable of walking on its own. We'd never been this involved with hydraulics before, so BioAlexi proved to be very exciting. The hydraulics gave us real power and superior fluidity of motion, far outstripping cable-driven mechanisms." BioAlexi's gross movements were controlled via real-time telemetry, his robotic exoskeleton containing a system of joints linking him with a puppeteer whose every motion would be mimicked. Finer moves, such as those in the eyes, utilized radio control. Consolidating all of the robot's major movements with a single puppeteer resolved a longstanding puppet issue. "When a character's movements get divvied up among several puppeteers, it can wind up awkward– like using two sets of hands to play a single saxophone. This particular approach made the operation run much more smoothly."



The towering Goliath robot– largest of the alien constructs– was digitally modeled and brought to life via computer animation at Tippett Studio.

BioAlexi is felled by heavy gunfire from the Sea Star crew, who then lay him out on the chart table. Suspecting he might be a secret Russian project, they begin examining him for clues. While probing his exposed brain, they inadvertently cause a short circuit– and the seemingly terminated robot goes berserk, literally trying to leave its skin. "There was a brief two-line mention in the script referring to a metal piece emerging from Alexi's body," Steve Johnson remarked. "We built on that description, eventually developing a neat little scene featuring what we called the 'biospine.' We storyboarded a presentation for John, who went for it right away." The action begins within BioAlexi's mouth. "The corpse's lips and jaw hyperextend as four cylinders start to protrude from its mouth. These gleaming pieces– which were developed by Christian Carlberg, our mechanical designer for the sequence– push outward in opposing directions until the jaw breaks. Then each cylinder unfolds three times, deploying like a giant switchblade. Two of these big knife blades fold back into the top of his skull and start cutting while the lower ones go beneath the jaw to do the same. A blade emerges from the neck and starts sawing down through the torso. Eventually the skull and metallic spine



A full-size hydraulic Goliath– spewing VisionArt electrical discharges during a scene in which tug navigator Kit Foster (Jamie Lee Curtis) is tortured– was constructed by All Effects.

rise up like a cobra to escape the body. Leon Laderach supervised all this, rigging air hoses to flail about as it breaks free."

Squeaky Molleno (Julio Machoso), having fallen prey to the droids, is next to be transformed into a biomechanoid. "Squeaky was usually a prosthetic makeup with some electronic augmentation, supervised by Mark Garbarino," Johnson explained. "We replaced one eye with a camera lens; then, to ensure it would be seen functioning, we installed a light behind the working iris. Another bizarre device attached to the back of the actor's head and was supposed to be sending probes down into his brain." XFX created a full back appliance for Squeaky when his shirt rips open to expose bare spine and metal forms protruding from his flesh. For a later shot of Squeaky ramming headfirst through a door in pursuit of his shipmates, Garbarino also engineered a squib-rigged kinetic cable puppet that could ram through the bottom of the door and explode from the volley of gunfire that greets it. "It was the only way to go. We couldn't have done anything nearly this drastic if we'd had to work with the actor's real face."

After Sea Star helmsman J.W. Woods (Marshall Bell) is killed, Foster seizes command from the unbalanced Everton, joining her remaining crewmates in a hunt to find and destroy the Volkov mainframe. Woods, after being ripped open by a robotic arm, is beheaded and segmented for spare part usage– a fact Everton learns when he attempts to negotiate with the alien. Foster's group discovers that the mainframe has been removed, and that the ship is now bound for land, sailing toward an advanced electronic facility. Realizing that the entity could infiltrate any computer system and transmit itself to all points of the globe, Foster accedes to Nadia's plan for destroying the ship, only to be confronted by a biomechanoid Everton.

The Everton cyborg, supervised by Joel Harlow, was handled in two different ways. Full-body shots featured a BioBob robot that reemployed the BioAlexi legs, but linked them with an oversized torso. "In the case of BioBob, the human torso beneath his face doesn't match him," Johnson commented. "That's because his head has been sutured onto the body of Woods, a heavier person." To differentiate this and the other biomechanoid forms from previous cinematic cyborgs, Johnson chose to downplay traditional blinking-light electronics and instead emphasize light forms. "Since the core creature consists entirely of energy, it made sense to develop a flowing, neon-electric look on the robots. We designed miniature neon and plasma balls that let us ramp up in intensity while changing color, then got Larry Albright & Associates to build them for us. For shots from the waist up– essentially the dialogue scenes– we did a rather lengthy makeup on Donald Sutherland. He wore a body suit with mechanical working parts. We put LEDs all over his head and a vision screen that flipped forward to cover one eye. All of that stuff can scare an actor, but Donald was a real trouper throughout the whole process."

Nadia vanquishes the Everton biomechanoid with a thermite grenade in a shot featuring a full-body rod-and-cable puppet with special blast-away parts. The beleaguered survivors prepare a multiple-grenade bomb, with which they hope to ignite the ship's fuel and destroy the entire vessel. But after setting the timer, they encounter the highest level of biomechanical construct– an eleven-foot robot, known on set as Goliath. Built by Eric Allard's All Effects, which also created seven-foot biomechanoids seen fleetingly during the BioSqueaky scenes, Goliath was somewhat anthropomorphic, with a helmet-like patch of flesh over its metal-and-wire skull. "We

worked pretty much from concepts provided by John Bruno and artist Steve Burg for both the seven-footers and Goliath," Allard recalled. "I got an okay to bring Chris Ross in to art-direct that aspect so it would conform exactly with what John had in mind." Mechanical designer Brent Bell interpreted the Ross drawings, building both hydraulic and rod puppet versions. "They had interchangeable heads, so we could switch to the puppet and still work in close proximity to the actors– after all, a 6000-pound robot could do a lot of damage, maybe even rip someone's head off." With a mere fifteen weeks from project startup to delivery, only a limited selection of hydraulic cylinders and components could be obtained, requiring All Effects to build Goliath mostly from off-the-shelf hardware.

Hydraulic Goliath was armature-mounted and operated with a Kuper Controls system provided by Interactive Technologies. Thirty axes of hydraulics and forty of radio control were employed– the latter used for fine moves involving arms and facial features. "The level of detail on this eleven-foot robot was fantastic," Bruno related, "but because so much of it was hydraulic, I couldn't puppeteer the creature in the way I wished. After a couple of weeks, the crew got Goliath to behave; but I had decided previously that if something didn't work on set, I would just shoot an empty plate and move on. So there were a lot of plates. Most of them fell to Lori Nelson, my second unit and visual effects co-supervisor, who did a wonderful job. She'd have to shoot passes with a four-by-eight-foot white card and strobes to suggest the creature's shadow and presence. It was very exacting work."

While the shooting of clean plates had allevi-ated long and frustrating attempts to achieve complex actions with the full-scale hydraulic puppet on set, the approach meant a substantial– and unplanned for– digital effort in postproduction. "The initial edict was to get the whole show in-camera without going to CGI," Allard recalled. "My feeling was, given enough time and planning, most of it could have been done live-action. But something this size required a tremendous amount of hydraulic support; and some of the engineering aspects had to be handled in 'seat of the pants' ways. After all was said and done, John decided he needed a CGI version to perform the kind of extreme actions dictated by the script."

Halfway through principal photography, Bruno contacted Oscar-winning animator Phil Tippett, an old colleague, about mobilizing Goliath. "It turned out to be one of these 911 calls," Tippett laughed. "Ideally, you become involved early in preproduction and can help drive the design process while choreographing cool bits of business– while also having sufficient time to perform the tremendous amount of planning that goes into establishing an efficient operation. Cobbling stuff together and making it all work as you go along is just a different, and from my perspective, more difficult way of working. We had to come up with ideas on the fly and implement them immediately."

“Phil took the job without ever even seeing the robot,” Bruno recalled, “and when Eric Allard sent the practical Goliath up to Tippett Studio, everybody freaked out. One look and immediately they knew this was going to be the most complicated CG creature ever, with eleven hundred parts. But once they stripped it down and modeled it in, Goliath began doing everything we ever wanted, and the CG element successfully cut back-to-back with the on-set Goliath throughout its scenes.”

Veteran visual effects artist John Bruno– directing his first feature film– confers with Jamie Lee Curtis on the Virus set.

Stringing together a background from several empty plates shot on set, Tippett’s crew created a Goliath motion demo– a test demonstrating one possible range of actions for the robot. “We hadn’t received any instructions about how they planned to cut the sequence,” Tippett said, “but when John saw what we had worked up, he liked our approach. The whole experience was a matter of coming up with interesting ideas that didn’t invalidate the on-set work, while building up a greater sense of menace for the Goliath character.”

Craig Hayes– a Tippett associate dating back to Robocop, for which he designed the ED-209 law enforcement robot– supervised visual effects and handled Goliath’s art direction issues. Hayes and Merrick Cheney scrutinized the Allard puppet body and head, taking comprehensive measurements prior to commencing to build the complex and detailed digital model, which even reflected the K-Y jelly and red food coloring smeared on the Allard puppet. Paula Lucchesi and the art department were charged with working up the textures and surfaces for Goliath, developing a variety of shaders while interfacing directly with Doug Epps in the programming department.

Animation was supervised by Tom Schelesny, with Pete Konig acting as senior animator. “Pete made things work really smoothly,” commented Tippett, “so a number of complicated shots often went right through. With all of these moving parts, there was the potential for Goliath to appear too busy, so we monitored the pantomime to insure that it kept looking like what it was– a multi-ton metal object charging around. It turned out to be pretty easy to animate the big stomp-around-the-set actions. Getting subtle bits on sixteen-frame push-in shots of Goliath was tougher, because we had to capture the live-action lighting precisely. Julie Newdoll, lighting supervisor and lead technical director, spent weeks figuring out a way to render and light the thing, since the files were so huge. Every background plate was 2K, and the character was pretty big, computationally. Zoe Peck was the lead compositor, blending Goliath into complex compositions. Zoe’s team also added fire and animated the electrical arcs– the energy force emanating from Goliath. Darby Johnston, our effects animation supervisor, created a plasma effect that energizes the biomechanical monster.”

Footage of the full-size prop on set, while useful as lighting reference, often handicapped the animation. “Really huge things can’t be choreographed very well,” Tippett stated. “Even with their budget, NASA couldn’t build something this size and make it move in the ways called for. Sometimes animators feel a greater sense of freedom when working if they can forget about the clumsy aspect of the object being referenced– you just don’t want it there. We always had to make sure our ins and outs matched to the Allard robot’s position, and that put additional limits on what our model could do in the scene. But, fortunately, we were able to invent some business in between.”

After placing the makeshift bomb, Foster is set upon by Goliath and falls into a flooded machine room filled with full and partial corpses. To represent these bodies– the remains of the Russian crew– XFX constructed thirty weighted and articulated dummies. Subsequently captured by Goliath, Foster is interrogated and tortured with violent electrical discharges created by VisionArt. “We had to carry the force of the entity’s energy through the on-set Goliath, then direct it in a menacing way at Jamie Lee Curtis,” Josh Rose observed. “This energy could be seen coming off the tip of his finger and areas around his head. We did a lot of it with lighting effects and lens flares to create these hot sources and the energy bolt, which tied in what was established at the beginning of the show– the essence, or spirit, of Goliath. One interesting aspect to the interrogation was that John Bruno didn’t want the energy arc to actually strike Jamie Lee. Instead he wanted an animation effect suggesting that the arc went through her, appearing on the other side. So there’d be a flash from his rod-tip, and an arc coming off the back of her head at the same time. That gave the effect depth and made it look more integrated and less applied.”

With guns blazing, Nadia and Baker attempt to rescue Foster, but Goliath remains impervious to attack. Richie (Sherman Augustus) turns up with a rocket launcher, felling the giant for a time. When Goliath reappears with the now-disarmed bomb in hand, Nadia allows herself to fall into the machine’s clutches. In a self-sacrificing, but futile attempt to annihilate the robot, Nadia opens fire on a pressurized canister, detonating it with explosive results. A tongue of the flame that engulfs Nadia passes narrowly above Foster’s form in a composite handled optically by Fantasy II.

Foster and Baker discover a jerry-rigged bomb – fashioned earlier by Richie from the warhead of a shipboard surface-to-air missile– then strap themselves into an emergency escape unit and rocket to safety just before Goliath and the Volkov are blown sky-high. Acme built the rocket motor and escape sled used for their getaway. “Production sent their live-action rocket seat over to us,” Mike Joyce stated. “It was a fighter plane ejection unit that had been adapted for on-set use. The design wound up changing a couple of times, so we built different versions before getting to the final, which featured the rocket booster as a separate unit tethered to the seat Jamie Lee sat in with William Baldwin. We made both parts from aluminum so they’d hold up to the pounding.” Wide shots of the rocket escape unit in flight utilized the model plus foot-tall figures of Curtis and Baldwin, also sculpted by Acme.

Chris Warren and Gene Warren III shot the entire escape sequence at Fantasy II. “The escape rockets seen in the side view and up inside the launch tube were shot motion control,” Gene

Warren recalled, “with live exhaust flames added as an optical comp. The ship’s exterior rocket doors were all done sixth-scale; but for the shot of the rocket yanking them away from the Volkov, we composited miniature elements with another flame element, and digitally animated the cable that linked the rocket to the escape sled.” The explosions that obliterate the Volkov were also accomplished at Fantasy II with pyrotechnics supplied by pyro supervisor Joseph Viskocil and foreman Robert Hutchins.

Through the course of its development, Virus had mutated significantly, but in the end remained a story about two people tough enough to survive everything man or machine could throw at them. In a behind-the-scenes parallel, first-time director John Bruno, too, proved up to the task of handling a sometimes excruciatingly difficult and complex shoot. “We began with a story that, initially, wasn’t entirely satisfying,” Bruno concluded, “then transformed it into a film I’m very proud to have made. Phil Tippett, Gene Warren, Steve Johnson and Jay Riddle were all friends and co-workers I’d known from years of working at ILM and Boss. On this show they really came through when I needed them, helping to establish a distinctive visual stamp for the picture. That aspect, coupled with our overall thrust to keep Virus grounded in a credible reality, made all the difference in the end.”

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image

A GORILLA NAMED JOE

ARTICLE BY SCOTT ESSMAN

When Mighty Joe Young premiered in 1949, moviegoers were surprised to encounter a kinder, gentler gorilla than his more famous celluloid predecessor, King Kong. Unlike Kong, Joe was not so much a fearsome monster as a loveable, if slightly oversized, family pet– a performance owing in no small part to the genius of special effects legend Ray Harryhausen, whose painstaking frame-by-frame manipulations of an armatured puppet on miniature sets brought the character so endearingly to life. Working under the supervision of the original King Kong stop-motion wizard, Willis O'Brien, Harryhausen spent two years laboring on the film, and the ensuing quarter century perfecting the stop-motion technique that would inspire a horde of young cinema enthusiasts. Nearly fifty years later, many such buffs of the original movie comprised the creative team assembled for a new Mighty Joe Young, a modern incarnation of the story, directed by Ron Underwood. The production– taking full advantage of the technological strides that have revolutionized the effects industry since Harryhausen's heyday– would resurrect Joe through sophisticated animatronics and suit effects by veteran creature creator Rick Baker and groundbreaking visual effects spearheaded by Dream Quest Images, with support from Industrial Light & Magic and Matte World Digital.

More an update than a remake, the current Mighty Joe Young chronicles the extraordinary friendship between Joe, a mountain gorilla of gargantuan proportions, and Jill Young, the orphan girl who protects and subsequently raises him

A giant mountain gorilla named Joe escapes captivity to roam the Hollywood Hills in Walt Disney Studio's update of the cinema classic Mighty Joe Young. While stop-motion animation had been used to breath life into the original Joe, the modern incarnation was achieved predominantly with a suited performer shot at forty-percent scale, augmented with computer generated imagery. Rick Baker and his Cinovation crew teamed with Disney's own Dream Quest Images to recreate the memorable character, with a helping hand from Industrial Light & Magic and Matte World Digital.

Director Ron Underwood confers with veteran ape performer John Alexander during Hawaii location filming for scenes set in Africa.

after both of their mothers are murdered during a vicious poaching incident. Twelve years later, zoologist Gregg O'Hara stumbles upon the duo and convinces Jill that the endangered ape's best hope for long-term survival is under the protection of his California-based wildlife conservancy. In the States, the much-heralded arrival of Joe and Jill prompts media interest that attracts the attention of the poacher responsible for their childhood trauma, who resurfaces with a plan to kidnap Joe and sell him off piece by piece on the endangered species black market. When that plan runs amuck, the fearful and confused gorilla escapes into the busy streets of Los Angeles, terrorizing the inhabitants and wreaking havoc throughout the city. Ultimately, though, the gentle giant's good-hearted instincts win out, earning him a reprieve and the admiration of his human benefactors.

In 1995, more than two years before cameras would roll on the production, David Vogel, president of Walt Disney Pictures, had begun exploring the feasibility of a Mighty Joe Young remake. With an early version of the script in hand– one that would later be rewritten– Vogel entered into discussions with Rick Baker, highly touted in the industry for his expertise in crafting gorilla suits. "Joe was, after all, the hero of this story," remarked producer Tom Jacobson, "and any time the character appeared in the movie, it had to be an effect of one kind or another. So even though the script wasn't the one we ended up shooting, the studio realized they didn't have a movie unless they could sustain the illusion that Joe was real. They could fix the story later."

Baker met with Vogel and other Disney studio executives at his Glendale Cinovation shop. "I showed them some of our old gorilla stuff, like the Digit suit from Gorillas in the Mist," Baker recalled. "I talked about the approach and how to accomplish it, and we agreed to an initial R&D period. I didn't want to do this movie unless we could somehow improve on what we had done in previous films. I knew it was going to take several years of my life, and I thought, 'If it isn't going to be different or better, why do it?'" Baker's acceptance of the assignment was also contingent on two important provisos: the hiring of seasoned ape suit performer John Alexander to portray the adult Joe, and of Vern Troyer, who, at twenty-seven inches tall and just fifty pounds, was a natural to play the gorilla as a baby. Baker had worked with both men before, teaming with Alexander to create White Eyes for Greystoke and Digit for Gorillas in the Mist, and with Troyer, more recently, in Baby's Day Out.

In June 1996, Cinovation began a preliminary design phase for Mighty Joe Young. Analyzing previous ape films, Baker and his artists, working with the studio– which had yet to greenlight the project or even assign a director– brainstormed ideas for the title character. "We didn't want Joe to be so stylized that he looked like a fantasy character," Baker observed. "The original Joe was cartoony in many ways, but we wanted our Joe to be very real– and attractive by gorilla standards." Concerned that if he did the design work himself, it might too closely resemble Digit from Gorillas in the Mist, Baker relied on Cinovation artist and sculptor Matt Rose. "Matt is an amazing artist. I gave him more responsibility than anybody else with regard to the look of Joe and making the suit as good as it could be. He took that responsibility very seriously because he knew this had to be better than anything we'd ever done before."

Besides locking in the gorilla's overall appearance, preliminary tests were done to determine the character's size. "Something I liked about the original Joe was that he wasn't King Kong size," Baker noted. "Although the studio wanted him bigger, I was pushing for Joe to be a size that you could believe might exist. I wanted something big enough so that the girl could stand beneath him in his quadruped stance and be surrounded by him, like someone in a doorway. But if it got much bigger than that, it would take it into too much of a fantasy realm." Rough drawings of Joe, created by Carlos Huante, were blown up in six-inch height increments, starting at nine feet, and the full-size gorilla blueprints then studied in relation to a human. Eventually, the decision was made to lock the character's height at thirteen and a half feet tall in full bipedal stance and nine and a half feet in quadrupedal.

Other determining factors in the look and design of the ape would depend on the performer inside the suit. "We knew that the majority of stuff in the film was going to be John Alexander in a gorilla suit," stated Baker. "So John's size and how much we could distort his body to look like a gorilla would determine what Joe was going to look like. We took a body cast of John in a quadruped position, and Matt sculpted a gorilla body on top of that to create a life-size maquette for a prototype suit. We hadn't worked out the face yet, so we just blocked that out in rough form on the maquette; but the anatomy was complete." 'Suit Joe' would be designated at forty percent of full size.

Concurrent with the early work being done at Cinovation was a similar effort underway at Dream Quest Images. Founder Hoyt Yeatman, who had come onto the project just a few weeks after Baker, faced a formidable challenge. "In my initial meetings with David Vogel," Yeatman recalled, "I had informed him that there were many technical issues that needed to be addressed and solved in order to create a convincing screen character." Besides the need for a CG gorilla to match the suited performer– a task that entailed the creation of computer generated fur, one of the most difficult aspects of digital character creation– the movie would also involve a grab bag of effects techniques ranging from simple forced perspectives to in-camera work on miniature sets to advanced bluescreen and digital compositing in order to give the forty-percent suited Joe his size and scale. "We ended up building some of the largest bluescreens ever erected, and matting in not just Joe, but entire jungle sets that precisely duplicated portions of the live-action locales. In order to make this film, we found ourselves using every trick in our toolbox, and, along the way, elevating each part of the process to a whole new level."

Yeatman's first order of business, however, was to convince studio executives– and himself as well– that the film could, in fact, be made. In order to determine if the bluescreen approach was even viable, a preliminary test was conducted in collabo-ration with director of photography Dean Cundey, who at the time was under consideration to helm the project. "Rick was still doing R&D," Yeatman recalled, "so we had John Alexander get into an old Digit suit that he had from Gorillas in the Mist, and we shot a simple walking test in Rick's shop with floor-contact, frontlit bluescreen, in four-perf Panavision with zoom lenses. It looked very promising, but it pointed out a problem that had not previously been identified. Although one visualizes Joe as being black, he is actually a very dark, brown-red. Typically, the way to light a gorilla like that is to backlight it; so what you get is translucent hair follicles that have this reddish tinge to them

that reaches a black level. In trying to pull mattes off the film, we saw some artifacts along the edges of the matte– a magenta line edge against the highlights."

After testing a number of camera lenses to isolate the red fringe, Yeatman identified the Eastman Kodak film stock used in traveling matte photography as the root of the problem. "Other people around town had dealt with the red fringe problem by changing the edge of their matte," Yeatman remarked. "But that was not something I could do on Mighty Joe Young because Joe was a furry gorilla and I would lose the character's edge. Film emulsion designers from Kodak came out to us, and within days discovered that the film had some artifacts that had been there the whole time. Because of digital technology we were only now able to see them." Working with Yeatman to correct the problem, Kodak produced an improved film stock in record-breaking time to accommodate the start of filming on Mighty Joe Young. "Kodak's rapid creation of that new film stock, in response to our tests, was unprecedented. That stock will enable all future bluescreen/greenscreen work to be free of the resident artifacts of the old stocks– a concern that has long plagued effects filmmakers."

Tasked with the creation of sophisticated gorilla suits for the title character, Rick Baker and his team began with a spandex muscle suit custom-designed for John Alexander. Cinovation supervisor Matt Rose fits an early mockup of Joe's head onto a prototype suit for testing.

Artist Aaron Sims details an animatronic head for the ape suit, one of several designed to deliver, via remote control, a broad range of realistic facial expressions and roars.

The underskull for the suit head was designed to attach to a fiberglass skullcap worn by the performer, who controlled the character’s basic head and neck movements.

Since it was a given that the majority of shots of Joe would be accomplished at forty-percent scale with a suited performer, Yeatman had many other issues to address, including the logistics of filming live background plates that would later be composited with bluescreen inserts of Alexander. “I had to be able to duplicate camera moves from our location shoots on a bluescreen stage,” Yeatman explained, “so we started looking into real-time motion control systems. Since most of the existing systems were very bulky and hard to take on location, we set out to build our own version– one that would enable us to precisely repeat true 3-D perspective moves on a bluescreen stage scaled to forty percent.” Working with engineer Mike Sorenson, an outside contractor, Dream Quest engineers Joe Hagey and Fred Iguchi built the first compact, high-speed-servo, real-time motion control field rig with a precision location track. “The Zebra dolly, as we named it, had the muscle to go fifteen miles an hour for shooting chase scenes through the jungle. At the same time, it had the precision to run in a scaled forty-percent version. This type of true perspective movement wouldn’t have been possible without the custom rig we developed.”

Research was also underway at Dream Quest to develop advanced survey techniques that would make it possible to construct, months later, spatially exact, forty-percent miniature sets for in-camera work with the suited Joe, as well as provide 3-D tracking information for the creation of virtual sets. “Simply putting out reference points– things like tennis balls to be tracked later– was not going to work,” Yeatman remarked. “We had to survey everything about each location, since we would need to rebuild every detail at a much later date. We ended up using AutoCAD to translate the survey data into set drawings from which miniature sets could be built.”

As the R&D effort at Dream Quest progressed, construction of a prototype ape suit and other

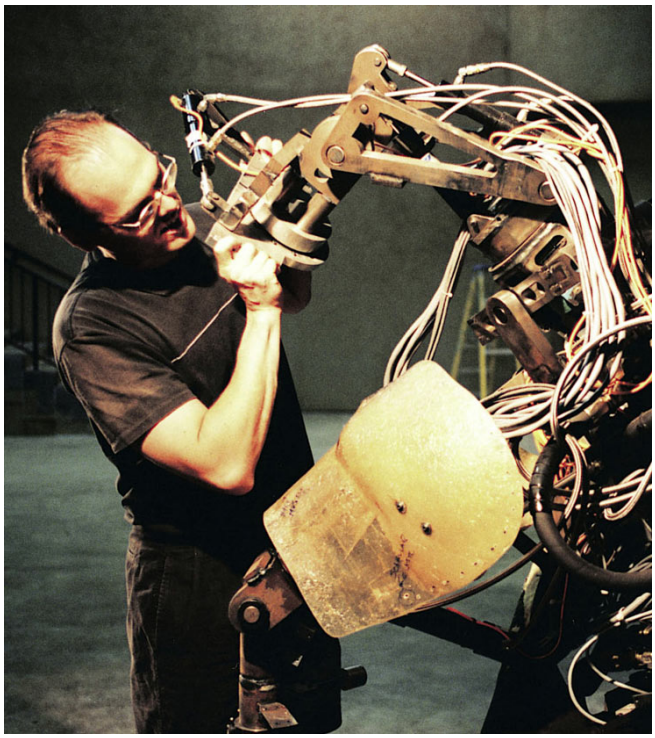
Hair supervisor Sylvia Nava hand-ties individual hairs for the gorilla’s thick fur.

The state-of-the-art suit incorporated numerous advances in ape suit technology, from more realistic eyes to improved arm extensions.

practical ape constructs were underway at Cinovation. Although the basic approach for the suit was similar to previous Baker creations– a lined muscle suit covered with a spandex foundation into which yak hair was hand-tied– Baker would incorporate numerous modifications to improve on the older designs. Chief among them were the eyes. “On Gorillas in the Mist, I had always felt that Digit’s eyes weren’t alive enough,” Baker admitted. “It’s hard to get life in the eyes of an animatronic character. The eyes for the Gorillas in the Mist suits had been complete spheres– a spherical hard shell for the eyeball with a spherical eyelid over it– a shape that made it relatively easy to do an eye-blink mechanism. But for Joe I wanted a more realistic corneal bulge– and a hard-shell eyelid would not have been compatible. So Kazuhiro Tsuji developed an eye-blink mechanism that functioned over the corneal bulge of the eyeball.” Referencing artificial eye technology, Tsuji carved striations into the eyes and sculpted them with deep pupils, lending a sense of dimension.

Complementing the ape suits were several full-scale, mechanical ‘Big Joes’ produced by Cinovation in varying poses for use on the live-action set. On location, Rick Baker tests the radio controls for a sitting Big Joe.

Johnnie Saiko Espiritu and Chris Tarin prepare to make molds for the Big Joe mechanical head, an exact scale-up of the forty-percent suit version, produced via cyberscanning.



Massive hydraulic rams, engineered by Jurgen Heimann and Paul Romer, were used to drive the movements of the large-scale animatronics. Heimann adjusts the hydraulic neck mechanism for sitting Big Joe.

In place of the flexible spandex chest used for Digit in Gorillas in the Mist, Baker would experiment with a new hot-melt adhesive for the chest of the Joe suit. “The hot-melt was a very fleshy, heavy material that gave the chest weight and bounce. It was incredibly stretchy, so we were still able to get into the suit through a little opening; but whenever John beat his chest, the added weight would make it jiggle.” For even greater realism, the chest piece was built clear up to the chin, which necessitated the addition of special harnesses worn by Alexander to support the added weight.

New and improved arm extensions were crafted by Nick Esposto and Rick Galinson, with hands that automatically folded and bent when weight was put on them. “On Gorillas in the Mist,” Baker observed, “the ape suits had arm extensions, but John couldn’t put his weight on them to knuckle-walk. We had to utilize special knuckle-walkers for that. Since those were sculpted as if the weight was on them, they looked awkward when John lifted his hands up; but for Gorillas, it hardly mattered because Digit was always in the jungle and you didn’t see them that much. Joe, on the other hand, was going to be walking on concrete and asphalt; and you would have noticed if the knuckles didn’t move.” The new extensions were fashioned in an open, relaxed position for general walking. When Alexander put weight on them, however, the hands automatically folded and bent appropriately with the aid of a sophisticated locking mechanism. “As soon as John put his weight on them, they locked. Even if the arms weren’t quite in the full back position, as long as there was some weight on them, they would lock in whatever position John had them.” Multiple sets of arm extensions– both walking arms and ones with dexterous hands– were fashioned for the Joe suit, in addition to glove hands used for tighter shots. Relaxed feet, for sitting-down shots, were

Radio control functions on the prototype full-scale head are given a dry run by Rick Galinson. Although slightly less versatile than the suit heads, the full-size replica was still capable of complex facial articulation.

Ron Underwood– with Rick Baker and crew at the Cinovation shop– during an early demonstration of quadruped Big Joe.

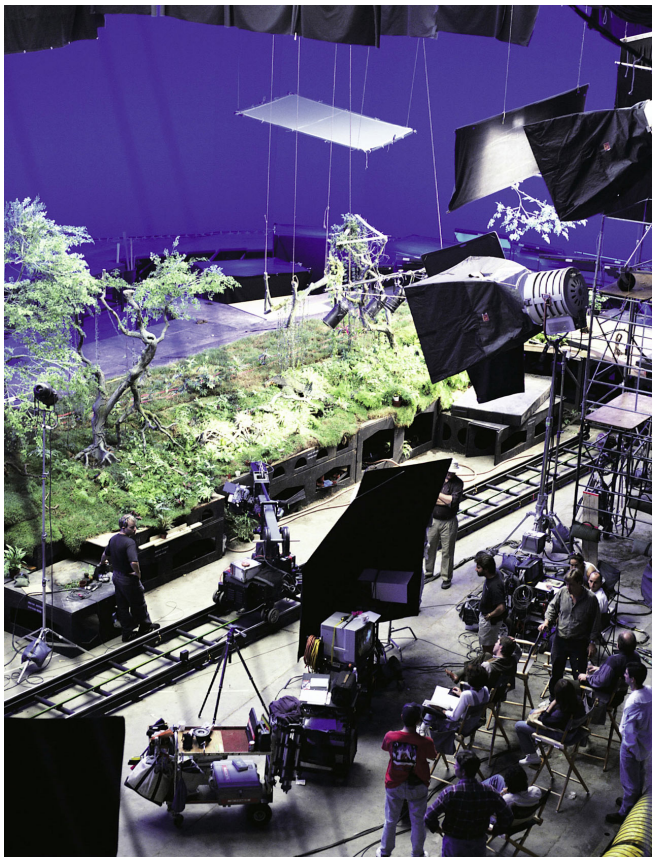
articulated so that when Alexander moved his own toes, the gorilla's toes would follow.

A key aspect of the suit development would be the creation of two fully-mechanical hero heads, capable of a wide range of expression. Fashioned out of foam rubber, after many experiments with hot-melt, one was a roar head designed for extra-wide mouth movement. "One of the things we really wanted to do with Joe," observed mechanical engineer Mark Setrakian, "was to have his mouth be able to go from a very tense, closed position to a full roar– the biggest roar we'd ever need to make. As foam latex typically will tear if you try to move it that far, a roar head in the past had to have a special skin sculpted just for that facial position, with the mouth already partially opened." For the Joe roar head, however, Setrakian devised a mechanism that would distribute the stretch evenly through the foam latex as the mouth opened to its maximum position, without resulting in tearing at the corners. Through puppeteering the lips and muzzle, Setrakian could also pull the lips in tight over the teeth and create a 'play' face, which on a real gorilla occurs when the upper lip completely covers the upper teeth and the lower lip hangs out.

Used only sparingly, one technique employed to impart in-camera scale to the suited performer was forced perspective. Crew members prepare John Alexander in the Joe suit for a forced perspective shot, elevating him on a platform to align him appropriately with the background.

For the most part, the approach of choice was to film Alexander on miniature sets or separately against bluescreen for subsequent compositing into plate photography. Ron Underwood prepares for a scene with ‘Blow Joe’– a lightweight, inflatable stand-in used for gauging eye-lines and lighting levels on set.

Whereas Alexander was essentially blind in the roar head, the other hero head, dubbed ‘video head,’ allowed for a modicum of vision by means of a tiny video camera mounted next to his cheek that sent images to a monitor in front of his left eye. Other than that, the video head’s only significant functional difference from the roar head was that its roar was not as wide. Weighing ten pounds apiece, the hero heads were packed with forty servos each, distributed over five radio transmitters, and were designed to attach to a fiberglass skullcap worn by Alexander over a firm foam pad that completely covered his head. Aluminum standoffs affixed the skullcap to the gorilla skull, allowing the performer to control basic head and neck movement. Two large servos drove the jaw movement, while three others, attached to cables laid along either inner side of the jawbone, actuated the tongue. When the cable slid down a track at the bottom of the jaw, it allowed the tongue to extend or retract. With facial expressions difficult to distinguish on the dark-skinned gorilla visage, Setrakian also added eye articulation that enabled the eyes to move in and out of the head. “If we drew the eyes in, Joe looked depressed,” said Setrakian, “and if we bugged them out, he appeared angry. It was one more thing we could do to play up his expressions.”



Composite elements of Alexander in the suit were photographed by Dream Quest on bluescreen stages erected in a Playa Vista hangar. Miniature foreground jungle sets that precisely replicated portions of the live-action locales enabled the suited performer to interact realistically with his environment.

A third head, deemed the principal stunt head, was fashioned for more complicated action scenes involving the suited performer. Capable of jaw movement– though not full range– as well as eye movement, the head was constructed with an open mouth, offering Alexander a much clearer field of vision. For most of his required running scenes, however, Alexander would wear an ultra-light stunt head that contained no mechanisms at all. “I could see pretty well through the nostrils and the mouth,” explained Alexander, “and could run anywhere in it and still know where I was going.” A fifth head, dubbed the ‘lightweight roar head,’ was capable of a very wide roar without the burdensome weight of the hero head.

For opening scenes in the film that would feature Joe as a baby, another Cinovation team, under the supervision of Aaron Sims, was charged with fabricating a Baby Joe suit for Vern Troyer. “We knew what size Vern was,” Baker explained, “so we made the suit to fit him without building it up too much. We wanted Baby Joe to be really small.” The suit exterior was made from yak hair specially braided and permed to duplicate the kinkier hair of a young gorilla. Construction of a mechanical head for the suit was complicated immeasurably by the size

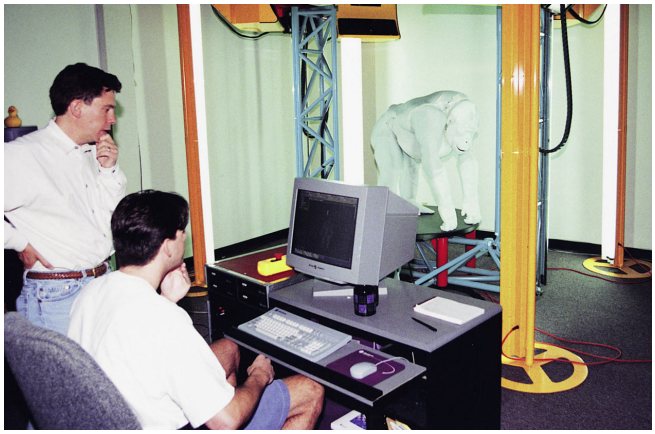
constraints under which the Cinovation team labored. “Immature gorillas’ faces aren’t as big proportionately as adult ones,” Baker explained, “and Vern has a large head, so we had very little space for the mechanism. In fact, the head stuck out from Vern’s face only about a half inch.” With Sims supervising the cosmetics for the costume head, Kyle Martin oversaw the facial mechanics, which included an ultra-thin eye mechanism positioned just in front of Troyer’s face, capable of blinks and four-way eye movement. Rather than constructing a fiberglass skull that would be attached with standoffs to the skull cap worn by Troyer, Martin fabricated the gorilla skull as solid plastic pieces that fit onto the performer’s face. “There were fiberglass forms around the teeth and jaws,” observed Setrakian, “and the area around the eyes was a very thin cast piece that incorporated the mechanism into it.”

Simultaneous with the suit work were the efforts of still a third Cinovation team– supervised by Eddie Yang– tasked with the construction of ‘Big Joe,’ a hydraulically powered mechanical rig that would be used for selected in-camera shots of the full-scale character. Added to the arsenal later were two more full-size mechanicals– ‘Sitting Joe’ and a lying-down version nicknamed ‘Dead Joe.’ “There was a limit to what the big hydraulic Joes could do,” Baker acknowledged, “but their advantage was that we didn’t have to do any opticals when we used them, and the actors could interact with them directly.” Using the original Suit Joe maquette, Yang’s crew first molded and cast a polyfoam version of the sculpture for cyberscanning at Cyber F/X in Glendale. Having determined that the full-size Joe would need to be two and a half times bigger, Cyber F/X carved, on their computerized mill, a polyfoam duplicate representing the scaled-up Big Joe. “A key concern was that full-size characters often don’t match their smaller counterparts very well. But the precision of cyberscanning made it possible for us to create an exact foam-carved replica.”

Hard fiberglass pieces were fashioned from the carved foam, and the scaled-up forms– representing the gorilla’s arms, legs and torso– were positioned on standoffs that screwed onto a steel armature. Exterior fabrication, by head Cinovation costumer Claire Flewin, included a giant foam rubber chest, foam rubber skin for the face, and polyfoam neck muscles. Built under the supervision of Jurgen Heimann, mechanics for Big Joe consisted of huge hydraulic rams in its arms, neck, back and head, designed by Heimann and Paul Romer. Placement of the rams allowed for realistic shifting of Joe’s weight forward and back and from side to side. “The one thing that the big guy did better than the suit was head movement,” remarked Baker. “The suit head pivoted from John’s neck, not the gorilla’s neck. But on Big Joe, we could make the neck pivot in the right place so that the head could actually move from side to side and up and down farther and more accurately than the suit.”

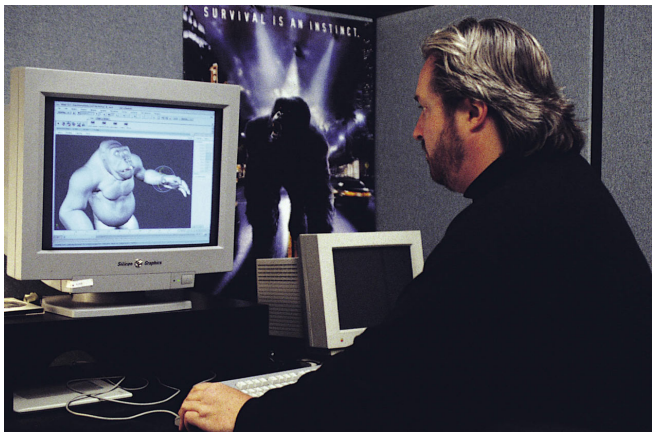
Various options were explored for the thick hair that had to cover the full-scale animatronics. “To do a hand-tied hair suit that size would have been a nightmare,” Baker said. “Plus how do you scale up hair? You couldn’t use yak hair on the Big Joe because it would look too silky. The only thing I could think of was horse hair, which is far too difficult and time-consuming to hand-tie.” For a solution, Baker turned to National Fiber Technologies, a company that manufactures artificial furs and that Baker had first used when making background suits for Gorillas in the Mist. “We sent them a bunch of horse hair that they wove into a spandex material. They sent it back, and we ended up doing a mixture of horse and very coarse yak hair.”

A more straightforward manufacturing process would distinguish the Big Joe head from that of the suited Joes. Implemented by Nick Esposto, it consisted of a fiberglass skull– a scaled-up version from the original cyberscan– with complex jaw mechanism that allowed the jaw to jut out or swing side to side. Since the Big Joe head was not designed to roar with the intensity of the suit heads, the lip mechanism was more conventional. “Even though Big Joe had very articulated eyes, lip functions, tongue functions and facial squint,” said Baker, “my feeling was to limit what it could do so that production would be forced to shoot the suit head for closeups. Of course, then I worried that they would still shoot the big head and I’d be sorry that we limited it– so we ended up adding functions.”



Selected action shots requiring Joe to perform in ways that exceeded the capabilities of a human performer necessitated the creation of a computer animated substitute, a task undertaken by both Dream Quest and Industrial Light & Magic. At Cyberware, Dream Quest visual effects supervisor Hoyt Yeatman and Cyberware software developer Christian Juhring obtain scan data from the Cinovation suit– covered in white lycra to facilitate the scanning process– to use as a basis for the digital model.

In early Fall 1996, Disney approached director Ron Underwood– a veteran of effects-oriented films such as Tremors and Heart and Souls– to take on Mighty Joe Young. With Underwood’s arrival, some seven months before the start of principal photography, the full production team was assembled, major script rewrites and budget issues were addressed, and effects storyboards were developed at Dream Quest. “We were up to about three hundred visual effects,” commented visual effects producer Anjelica Casillas, “and most of the next four months were spent in constant production meetings with the studio, with Rick Baker, with mechanical effects supervisor Allen Hall, with miniature set designer Forrest Leathers, going over the methodology of how we were going to accomplish these shots, how we were going to plan the location photography, which shots could be done bluescreen, which had to be done CG and which could go either way, depending on the final action. It was great to have everybody at these meetings, because we could find out what the production had in mind, find out what resources were allocated, and give the filmmakers several options. It was a very cooperative time, but I think we all began to realize just how huge this show really was and the enormity of the task and challenge at hand.”



Embellishing the basic cyberscan, Dream Quest modeler Hal Lewis referenced extensive photo studies of John Alexander in the suit while fashioning the CG character, which had to replicate the predominant live performance present throughout the film. Cutting-edge software was required to render and animate the gorilla and to provide controls for grooming its thick hair.

Throughout that period, the research continued, with Dream Quest conducting a wide range of tests involving forced perspective, nighttime photography, bluescreen compositing and such– many in conjunction with Ron Underwood and director of photography Don Peterman. “Just as you would experiment with makeup, lighting and costumes on a movie star,” noted Underwood, “we wanted to do that with Joe. Don Peterman and I needed to learn about angles and size issues because we were making a larger-than-life gorilla. We had to know what would give him scale, ferociousness and muscularity when we wanted that, and empathy when emotion was called for.”

One elaborate bluescreen test entailed a long moving shot of Jill running ahead of Joe through the forest. “It was a really good test,” commented Yeatman, “because we all got a taste of what the process was going to be like in making this film, how long setups would take and the complexities involved.” In a wooded area of Griffith Park in Los Angeles, fifty to sixty feet of track were laid down for the motion control camera. The site was surveyed and an actor was filmed running from the woods. Later, on a stage at the former Hughes Aircraft facility in Playa Vista, a giant bluescreen– ninety feet wide and thirty-five feet tall– was erected. Using survey data gathered from the Griffith Park location, Yeatman and his team created a forty-percent-scale foreground section of the woods, using miniature plants that matched full-size ones in the real environment, then filmed Alexander in the prototype Joe suit running across the bluescreened expanse.

“One of the things I wanted to do was test the video system on the camera,” said Yeatman, “We had established a high-end color video tap, which recorded on Beta tape and video disc recorders, and shot the whole effect in that. Then we brought an Ultimatte system on board so that we could see an instant composite, and Ron and Rick and everyone could check the performance. We worked with John Johns from In-Sync and used the digital analog Ultimatte to work out a time compression algorithm that would allow the recorded live-action background plate, shot at 24 frames per second, to be compressed and combined– frame accurately– with the overcranked 32 frames per second of the bluescreen shot, so that the video tap images could be composited in real-time and still remain perfectly in sync.”

“We spent two and a half days just setting up that shot and lighting it,” stated Yeatman. “The test illustrated the enormous light levels required to shoot Joe in the suit and with the miniatures. Typically you have to be about two stops deeper than what the original plate was shot in; and since Joe was for the most part black, and we wanted to see details in the shadows, we had a very difficult time lighting him. It required upwards of 1500 foot-candles. Plus we were trying to simulate daylight exteriors; so in the ceiling we had Dino lights and 20K fill lights. Then there were the Kino Flos to illuminate the bluescreen.”

Throughout the testing period– in fact, from the earliest days of its involvement in the picture– Dream Quest had also been laboring to create a computer generated version of Joe that could be used in instances where the character’s actions exceeded the capabilities of a suited performer. “We knew we were going to face certain scenes where a man in a suit would not work,” Yeatman explained. “With a CG character, we could go a step beyond the man-in-a-suit approach and use it to do things that would have been impossible for John to do– like climbing a

Ferris wheel or smashing a Mercedes. Even in terms of facial animation, we could go beyond the animatronic Joe. While each control in the animatronic could be mimicked digitally, we could also reorganize and extend the controls to push Joe's expressions to new extremes."

Early on, a strategy session at the company had been held to determine what kinds of technology would be required for a digital Joe. "The biggest hurdle was getting photoreal hair," commented associate visual effects supervisor Dan DeLeeuw. "One of my first involvements with Joe was researching what had been done with hair and breaking down all the different qualities of the hair that we'd eventually need. I figured out what kind of tools were required for combing the hair, the curl, kink or clump. I printed out a few hundred pages of different types of hair solutions that were out there. But ultimately, I decided that we had to write our own from scratch. So we started recruiting programmers."

A core digital crew was assembled that included DeLeeuw, supervising character animator Rob Dressel, technical director Patrick Taylor, software programmer Rev Lebaredian and digital hair texturer and groomer Colin Eckart. Lebaredian began development of a proprietary hair renderer, dubbed 'Yeti,' that could literally grow hair on the model's surface. "To simulate hair is one thing," noted DeLeeuw, "but since Joe's hair subtly changes throughout the movie, we had to be able to control, comb and groom it– which was another issue entirely."

Key to the Yeti hair rendering program were extensive functionality and tool sets that would enable the digital artists to control such things as hair dynamics and inertia, motion blur and self-shadowing– a volumetric function that scatters light throughout the hairs. A clumping tool controlled both comb and deviations of the fur, giving it curl and kink so that it did not appear too perfect, as is often the tendency with digital hair. Colin Eckart developed and supervised tools for grooming the fur, a tricky endeavor that entailed reproducing the ever-changing groom tactics of the Cinovation suit. "On set there were people grooming Joe for each shot," DeLeeuw elaborated. "So we got photos of the suit and figured out the key positions in which his grooming changed and how they combed him. If he was down on four legs, the hair pointed down across his belly. If he was standing up, they combed him down so that the hair was flat." With nearly 3.5 million hairs covering the surface of the model, it would have been impossible to manipulate each and every one; hence a software tool was developed to manage the hair in grouped areas via strategically positioned guide hairs. The program then interpolated the remainder.

Several months after the digital development endeavor was underway at Dream Quest, Yeatman executed an elaborate test shot to demonstrate to the studio that they were on the right track. The thirty-second test would feature a CG Joe walking up to Pasadena's City Hall, rising from quadruped to bipedal position, pounding his chest, then climbing up the main tower. "At the time, Rick was still fabricating the suits," said Yeatman, "so we took the next best thing, which was a crude foam version of Joe, and used that for scanning so that we had a basic physique of the character. Our software had been in development for several months, and we had a preliminary hair program– enough to put it all together and see if it was going to work. Further, I wanted to see if animation could drive this thing or if it was going to require motion capture. I thought if anyone is going to have success with motion capture, we would because we'd be taking the guy in a suit and essentially cloning him."

With digital encoders set on the camera to test a three-point tracking system, and ping-pong balls set about the location for eye-lines, a motion control plate of people running away from City Hall was filmed. Digital artists replicated the environment in the computer and assembled the shot, animating their dig-ital Joe and inserting him into the plate photography. “It was an ambitious test,” recalled Casillas. “We pretty much went all out. We tried to put the gorilla through every range of motion that we thought we were going to use on the film so that we would know up front what kind of a model we had to build and what sort of animation tools we would need.”

Stumbling upon Joe in his native habitat, zoologist Gregg O’Hara and a team of trackers attempt to restrain the huge gorilla– computer generated by ILM– in order to obtain a blood sample for study. Under visual effects supervisor Jim Mitchell, ILM completed ten CG shots for the sequence, a task that demanded a digital ape capable of holding up to daylight scrutiny and close camera work.

One of the upshots of the test was Yeatman’s decision to discard the idea of using motion capture as a means of animating the ape character. “As part of the test, we had gone to House of Moves in Venice and set up some motion capture with John in a muscle suit with motion balls on it,” Yeatman elaborated. “Although they captured the motion very well, we realized there were pitfalls to that approach. There is no good system to edit motion capture data in a way that an animator would like to see it edited. With even simple changes, the data quickly starts to unravel and you’re fighting the technology. So unless you get exactly the performance you want, it doesn’t get you very far. At that point, we decided that any complicated motion shots– running, jumping or climbing– would have to be animated without the aid of motion capture.”

Mitchell– with animation supervisor Daniel Jeannette and associate visual effects supervisor Carl Frederick– studies one of the shots.

But the digital team had yet to create a fully detailed, working CG model that reflected the sophisticated suit under development at Cinovation. “Although we had pinned down some of the technical aspects in doing the test,” related DeLeeuw, “we still had to learn the entire process of how to make a guy in a suit look like a gorilla. Now we had the opportunity to see what Rick was doing, how he proportioned the suit around the man. Even though John’s legs were long, you could see where Rick had taken some of the padding and let it drape down into the upper thigh so that the legs still pivoted where a man’s would, but the suit went down below that. Some longer hairs from the ape’s rear end also extended further down John’s legs in order to make them appear shorter.”

To produce an accurate digital model, the Dream Quest team obtained scan data of Alexander in the muscle suit, covered in a white lycra skin fabricated by Cinovation for scanning purposes. “We chose a real-time, full-body scanner at Cyberware,” said Yeatman. “In fifteen seconds, it does a two-meter scan and you get a 3-D snapshot of what the character looks like. It gave us a data cloud– hundreds of thousands of little points hanging in space that defined the surface and gave our modelers something concrete to work with.” Higher-detail areas, such as head, hands, feet and tongue, were scanned at NVision, from maquettes created by Baker’s crew. From the scan data, geometry was built and the character modeled and touched up using Alias/Wavefront’s Maya sculpting software. “Dream Quest began using Maya while that software was still in its earliest pre-alpha form, and the work continued all the way through Maya’s ‘shrink wrap’ incarnation. In the process, we were instrumental in developing Maya, now an industry standard.”

The mandate to create a CG model that accurately reflected Alexander in the suit presented special challenges for the character model team– in particular, animation technical super-visor Danny Speck and modeler Hal Lewis. In order to develop appropriate controls for the internal skeleton that would drive the surface movement– and any secondary animation, such as muscle rippling– Speck and Lewis used as reference extensive photo studies taken of Alexander. “We had John come out here, and we photographed him in the suit standing with his arms up,” stated DeLeeuw. “Then we took the same pictures of him without the suit. I went into Photoshop and put the two images together so we could see where the man fit inside the gorilla. Later, when the requirements were even tighter for matching John, we filmed him from two different angles going through his motions. That way we could see how the foam padding in the suit moved and shifted as John moved. Even though we had figured out where all the pivot points were, one of the biggest problems in replicating the movement was that the suit had these big padded shoulders. When John went down into a four-legged position from a standing pose, the shoulders would roll forward. It was an entirely natural movement, but we had to figure out how to duplicate it.”

To accommodate the demands of the CG character’s facial animation– a factor that was essential to achieving an expressive performance– controls were fashioned to manipulate the mouth, cheeks, lips, eyes and brows. “The challenge was not to recreate the facial characteristics of a real gorilla,” DeLeeuw remarked, “but to replicate the nature of the animatronic ape as closely as possible.” A proprietary facial animation system, devised by DeLeeuw and Patrick Taylor– with code written by programmer Sean Jenkins– provided animators with a user interface that could store poses and set up all of the slider controls in one spot for easy access.

For those areas of the gorilla not covered by hair, Jenkins developed a proprietary skin shader, featuring multiple levels adjustable for transparency, texture, blood layer and reactive surface qualities. Another proprietary system to control muscle jiggle was designed by Patrick Taylor, who customized Maya tools to create the function. Based on the movement generated by the animation, the tool would be put to use post-animation, but before rendering, in order to ensure that all of the physics would be right.

In May 1997, principal photography for Mighty Joe Young was at last underway, with the production traveling to Oahu– a location that would double for the lush mountains of central Africa– to film the movie's early scenes. First on the slate was an opening shot of nine-year-old Jill Young (Mika Boorem) and her naturalist mother (Linda Purl) observing and photographing a family of mountain gorillas. The scene, which featured Joe as a youngster, scampering about in his jungle habitat, was realized with Vern Troyer in the Baby Joe suit. "Vern really understood gorilla performance," commented Underwood. "He's an incredibly strong guy who had to do a lot of stunts, and we put him through every possible extreme physical situation. I wanted to have the movie open with Baby Joe swinging from a branch in a tree and dropping; so Vern had this huge stunt to do right off the bat." To articulate the suit, a Cinovation puppeteer worked eye movements in the Baby Joe mechanical head. Another puppeteer controlled the lips, while Troyer opened and closed the jaws himself. Included in the gorilla troupe are Baby Joe's mother, a silverback, and two other adults. As they would only appear briefly in background shots, Baker opted to refurbish gorilla suits from Gorillas in the Mist for the sequence, in lieu of building new ones.

In a following scene, Strasser (Rade Serbedzija) a hunter intent upon poaching the endangered mountain gorillas, leads a group of men in a nighttime raid on the troupe. The sequence was filmed on a jungle set built at Disney's Golden Oaks Ranch in Santa Clarita. Alerted by the alarm cries, Jill's mother rushes to the ape troupe's defense as the terrified Baby Joe escapes, hiding with Jill under a nearby bush. Closeups of the two were achieved with a Baby Joe mechanical head and torso, built by Cinovation mechanic Mike Elizalde and puppeteered from below set by Elizalde, Jurgen Heimann and Mark Setrakian. "The puppet head was the same size as Vern's suit head," Setrakian said, "but had more expressive capability."

The night hunt sequence concludes with the tragic deaths of Jill's mother and Joe's, both victims of the poachers' bullets. The narrative then transitions twelve years into the future, with the arrival in Africa of zoologist Gregg O'Hara (Bill Paxton) on a mission to identify and study animal populations. Venturing into a forbidding tract of jungle, O'Hara and his trackers stumble upon the gorilla habitat, coming face to face with the now grown Joe– fully twice as large as a normal mountain gorilla. Determined to bring back a blood sample as proof of Joe's existence, O'Hara convinces his trackers to pursue the ape.

Plate photography for Joe's initial appearance in the movie– and for all of the subsequent shots consigned to bluescreen compositing or digital character insertion– would be captured by Yeatman and his crew, who were on hand every day of the Hawaii shoot as an integral part of first unit production. "When we went out to shoot plates," recalled Yeatman, "we found ourselves juggling with the enormous logistics of the task– getting the camera trucks ready, gathering survey data, figuring out how much track we would need to lay, what portion of the forest we would have to chop down, what we were going to art-direct, where the matte lines would be for the bluescreen shots, and so on." To give the actors an eye-line reference, Yeatman had Dream Quest's digital department design a lightweight, full-size, inflatable version of Joe– dubbed 'Blow Joe'– that could be easily carried about on location. "I found a company in Boulder, Colorado, that makes blimps; and we sent them our digital files to use. They made us a quadruped version and one in a seated pose. You plugged them in, and thirty seconds later they

inflated. It was a really good tool because it gave the DP something tangible to light and it allowed the actors to visualize Joe and see how much space he actually took up."

Ten shots in the elaborate 'roping sequence' that follows– so called because in the original film, Joe's pursuers had used nets and lassos– would require the insertion of a CG Joe into the daylight jungle exteriors, a task handed off to Industrial Light & Magic in order to afford the Dream Quest digital team time to concentrate more fully on its nighttime CG shots. At ILM, visual effects supervisor Jim Mitchell and producer Mark Miller were given responsibility for creating a CG Joe for the sequence. "I knew it was going to be a four-month process to produce a character whose hair looked and moved right, and that was correctly lit," remarked Miller. "Dream Quest gave us their animatics and a static plastic render of their CG Joe. That first frame of reference is so hard to get; so even though our hair system is totally different from theirs, just getting the initial plastic creature in the correct size was half the battle."

Angered by the chase, Joe turns the table on his pursuers, grabbing O'Hara (Bill Paxton) by one foot and dangling him upside down. Originally slated as a forced perspective shot, it was executed instead as a composite, with Dream Quest matching a bluescreen element of John Alexander in the Joe suit miming his action to coordinate with footage of a Paxton stunt double hanging from a rig.

Not only did their CG character have to hold up to daylight scrutiny, ILM also had to animate the character to run full-tilt. "Since John was in the suit for ninety percent of the Joe shots in this film," noted Mitchell, "we had to be dead-on in matching the details of his performance." Working on a parallel track with the CG Joe in development at Dream Quest, ILM modeling supervisor Paul Giacoppo used ISculpt and Alias to create a 3-D geometry that animators could manipulate. Then Viewpainter Rebecca Petrulli-Heskes took that geometry and devised texture maps for the gorilla's surface details, including wrinkles on his face, while enveloper Michael Corcoran created the deformation of Joe's skin. From this incarnation, associate visual effects supervisor Carl Frederick, together with Petrulli-Heskes, facilitated the creation of hair and overall matching of the CGI version to the suit. "It was one thing to precisely match the distinctive features of a head that didn't have any hair on it," said Frederick, "but the parts of the head that were covered with hair took on an entirely different shape. I decided to resurrect our

Wrapping up the film's first act was a scene in which Joe and his lifelong companion, Jill Young (Charlize Theron), standing atop a mountain ridge, bid a bittersweet farewell to Africa before journeying with O'Hara to a nature conservancy in California. Utilized in the scene was the quadruped Big Joe, transported to the Hawaii location site and puppeteered by the Cinovation crew.

generic monkey character from Jumanji and bring him up to date using ILM's new proprietary fur rendering system, which not only regulated lighting of the subject but also generated the fur. Once I understood how to make the Jumanji monkey look good using the new system, the knowledge gained was translated into making our CG Joe."

After testing and debugging various facets of the system, Frederick endeavored to create a digital method of simulating the dynamic motion of hair. "Fortunately, ILM staffer John Anderson was already working on a cloth simulation. Hiromi Ono adapted that research, which allowed us to create ripples in the surface of hair, tufting or clumping, and hairs sticking together. She integrated that into our shader, which draws the fur as it is getting rendered so that, on a per-frame basis, it translates how to move the hair. Eric Texier added debris in the form of minute grass fragments, and I incorporated and extended the fur dynamics in order to work in our shaders." To accommodate the millions of hairs in Joe's thick fur coat, Mitchell, Ono and Frederick implemented a method whereby software controls regulated the hair in grouped sections. "We simulated a smaller number of hairs as a sample, then interpolated to get the rest. By examining the suit, we determined the length of the hair over different parts of the body. Then, in levels corresponding to ever more sophisticated simulations of its local and global properties, we replicated the specific character of Joe's fur. The process was more software intensive, but saved us a lot of time in the end."

Animation of the figure in Softimage was overseen by supervisor Daniel Jeannette. "We didn't want to simply create a run cycle for our CG Joe," stated Mitchell, "since there was much more subtlety in the way John Alexander performed in the ape suit. John is very knowledgeable about gorillas and how they act and move; and we wanted our CG Joe to seem aware of his environment, looking at the vehicles chasing him and making eye contact with the trackers." At one point during the chase, Joe is cornered by one of the jeeps and roars directly into the camera view. "We were right inside his mouth on that shot. The image was a bit overlit, but we wanted to take that dramatic license so you could see his tongue and teeth." In a succeeding shot, the closeup gives way to a view of the gorilla pounding the windshield of a vehicle. "Since we were so close to the character, it was critical to match both the continuity of action and the look of the fur on the suited Joe." For a wide shot of the ape fleeing from a flipping vehicle, ILM added a CG Joe without the benefit of tracking information. "That was never intended as a CG shot; but when Ron and editor Paul Hirsch got into editing, they felt it was needed. Cathy Burrow rotoscoped Joe, first behind the truck, then passing behind trees."

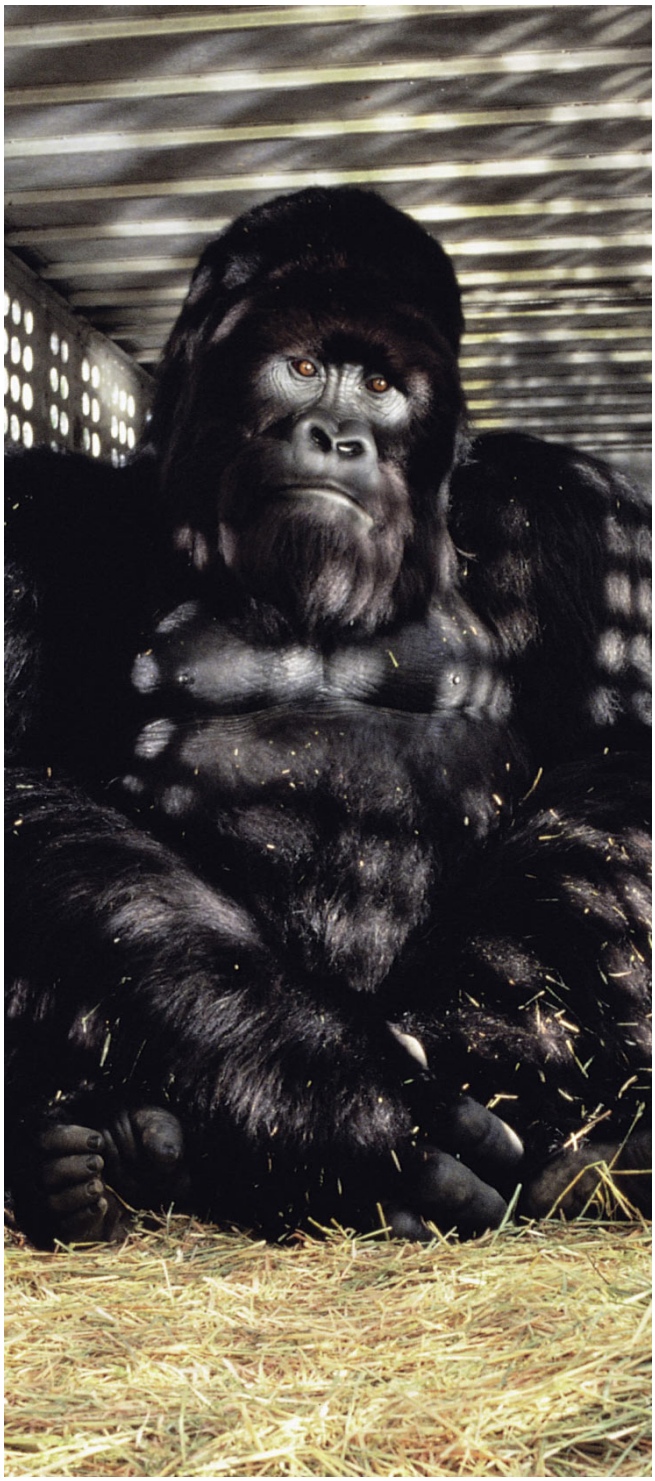
Weary of the chase, Joe wheels to face his pursuers, angrily batting one of the vehicles and causing it to swerve. To match backlighting on a tracker in the jeep, technical director Linda Siegel supervised the dynamics of the gorilla's fur kicking up and catching the light, then flopping back down. Julie Nelson animated the gorilla's reaction, while Steve Nichols animated him for a following shot– a POV from behind the ape and a pursuing vehicle. ILM stop-motion expert Tom St. Amand animated a CG Joe and chain for a subsequent view of the gorilla being snared by one of the trackers. Technical director Jeroen Lapré integrated the image with a live-action element of the vehicle being pulled by the chain. Jeannette animated the concluding shot in the sequence– a brief wide view of Joe continuing to pull the chain across the path of the jeep.

Unsuccessful in his attempts to get a blood sample, O'Hara doggedly tracks Joe to the edge of the forest. Infuriated, Joe turns on his pursuer, lifting him off the ground by his foot and dangling him upside down. Originally the shot had been scheduled as a forced perspective effect to be filmed by Yeatman on location with Alexander in the ape suit. However, unpredictable weather and poor lighting conditions necessitated a change in plans, and the performance was instead recorded by Dream Quest on the bluescreen stages at Playa Vista, with Alexander miming the action. Inserted into the shot was a separate bluescreen element filmed with a stunt double for Bill Paxton, suspended upside down, moving in sync with Alexander's motions. For detailed closeups of the gorilla's muscle-bound arm reaching for O'Hara, Baker built a full-size, articulated mechanical appendage, substituting a rigid version for shots in which the ape is seen picking up the character. "The foam rubber arms consisted of horse hair over fiberglass forms affixed to a metal skeleton," explained Baker. "We engineered them with electric motors that pulled the cables, moving the parts of the arm. We had a waldo item that a puppeteer wore so that if he moved his wrist or fingers, the hand did the same thing. It functioned like a telemetry device."

Jill (Charlize Theron), now a young woman, intercedes, commanding Joe to release his captive. Persuaded by O'Hara that Joe will fare better under the protection of his wildlife conservancy, Jill prepares to accompany the zoologist to the States, her gargantuan friend in tow. For a shot of Jill and Joe atop a mountain ridge, gazing one last time over the wilds of Africa, the full-size mechanical Joe was used. "Everybody felt that it was misguided to have to haul this big thing all over our location," Underwood conceded. "But I said, 'Wouldn't it be great to have Jill and Joe standing on a mountain ridge together in Africa, interacting in a way that could not be achieved in any other fashion?' Rick's concern was that the full-size Joe would break during its transport to Hawaii– but it didn't. The thing had incredible mechanics, and Rick's crew was terrific. We put them through a real test in the mud and the rain, having to forklift Big Joe around and crane him into places. Getting the hydraulics and motors and pumps into these remote spots was pretty tough, but everyone really got into it."

The conclusion of the Africa segment of Mighty Joe Young would coincide with the wrap of principal photography in Hawaii. As the action shifted to Los Angeles locales for the film's second act, Rick Baker's key puppeteering crew spun off with Hoyt Yeatman and his stage crew to begin an intensive seven-month period of work at the Playa Vista facility, where Dream Quest had erected two gigantic bluescreens– one 50 feet high by 250 feet wide, the other 50 feet square– to shoot composite elements of Alexander in the suit. For the jungle scenes, so that Alexander would appear to be interacting physically with the environment, large expanses of miniature jungle settings were built to blend with the real foliage shot on location. "The bluescreens had to be as large as they were," Yeatman elaborated, "because we weren't just matting Joe against bluescreen, but within an entire miniature environment that matched the live-action backgrounds shot in Hawaii. We wanted to see ground contact and bushes and foliage being squished whenever Joe moved, as if a big bulldozer were coming through. In preproduction, we had done tests with silks and plastic flowers and knew that wouldn't work, so we had started photographing the kinds of plants we would be encountering in Hawaii. Forrest Leathers determined what species of plants existed in full scale and in forty-percent scale. He

had a whole nursery with him in Hawaii; and when we were shooting the plates, we would talk about what part of the frame would be miniature and what part would be background. Many times, we would tear away foliage in the foreground and some of the transition and border areas, and insert full-scale plants that we knew we could duplicate later in forty percent; so when they were side by side in a composite, they would look homogeneous." Using real plants for the miniature sets had its disadvantages, however. "There was so much light on the bluescreen stage that everything would start to wilt after just a few minutes. We were constantly having to water and change out the plants. Then, during the weekends, we'd set up grow lights on the stage so that the plants wouldn't die. We would come back on Monday morning, look through the camera, and to our amazement discover that over the weekend the set had actually grown!"



Following his arrival in the United States, Joe is transported in a livestock truck to his new habitat. Views of the confused gorilla peering out of the vehicle at passing freeway traffic made use of a miniature truck with the suited Alexander inside.

Also enduring the blazing hot lights on the stages of Playa Vista was John Alexander, whose ape performance would begin to take shape as Dream Quest labored to complete some 108 bluescreen shots involving him in the suit. “This was the first serious work that we did with John,” recalled Mark Setrakian, who served as primary puppeteer for the Cinovation team. “It was really the beginning of getting into our groove, into the personality of Joe. Here we started to get a sense of what Joe was going to be like and how he was going to look and behave.” While Alexander performed Joe’s body movements, the puppeteering team articulated facial animation via a remote control station, designed and built by Setrakian and Kyle Martin, and jokingly referred to as ‘WAC’– for ‘Weird-Ass Controller.’ Setrakian operated the device via two sets of controls– a nose and upper lip mechanism for his right hand; and a lower jaw and lower lip mechanism for his left hand. Aided by two transmitters, each hand could puppeteer eight channels of information, with six inches of left, right, forward and back articulation possible via slide tables. “The long throw of those tables meant that I really had to use my body when I puppeteered– and that made it kind of fun. Once I got used to the controls and what they did, I could forget about what I was doing physically and just concentrate on Joe. I wanted the WAC to be more like a musical instrument and less like a radio transmitter.” Working in coordination with Setrakian was puppeteer Steve Sherman, who controlled the tongue, cheeks and eye squints, Mike Elizalde, who puppeteered the eyes, and Jurgen Heimann, who moved the brows– all with standard radio-control units.

For a shot heralding Joe’s arrival at the conservancy, Matte World Digital was given live-action plate photography filmed at a horse ranch in Hidden Valley, which served as the conservancy locale.

MWD enlarged on the setting by adding a digital matte painting of the compound buildings, complete with flags flapping on flagpoles, and a rhinoceros captured as a greenscreen element at the San Francisco Zoo.

John Alexander would draw on every bit of his keen knowledge of primate behavior and ample experience as an ape suit performer to do justice to the suit and create a character that was both realistic and expressive. “I tried to get a picture in my mind of how Joe would move and react,” recalled Alexander. “I found Joe through his physicality, and transferred that to my performance.” At five feet seven, weighing just 150 pounds, Alexander had been repeatedly put to the test in previous ape suits– but Mighty Joe Young would stretch the limits of his endurance. “As always happens with a guy in a suit,” commented Baker, “the performer is sweating his brains out, blind and trying to hold this ridiculously heavy head up. It’s a thankless

job, and John is the best there is at it. He has superhuman stamina and knows gorilla movement better than I do. The movie simply could not have been made without him."

For efficiency's sake, and to get as much mileage out of the Playa Vista stages as possible, Dream Quest had two or three setups going at once. "We'd be planting one setup while shooting another and prelighting a third," recalled Anjelica Casillas. "It was like Santa's workshop, walking in there. Everybody was doing something." Although the video assist that Yeatman had developed in collaboration with In-Sync provided a reasonably good instant composite, additional means of ensuring that the complicated setups on the bluescreen stage were working as planned were also employed. "You really couldn't distinguish fine points in video resolution," said Yeatman. "So we brought in a Mac and used an ISDN line to connect it with Dream Quest and our compositing team back at our studio, under the supervision of Blaine Kennison. The night before complicated shots– ones that involved real-time motion control that had been scaled-down from the live-action shoot to the bluescreen, or those where you saw floor contact with foliage– we would do a wedge test. We used a forty-percent dummy version of Joe as a stand-in for John, and would shoot a few frames with all the appropriate lighting in place. That night, it would be processed at Consolidated Film Industries– which did the processing for the whole movie– and rushed to Blaine at six or seven in the morning. His crew would scan it, and by 11 a.m. we would have a film composite. That image was assessed and sent back as a high-rez image that we could then bring up on the computers and show to all the appropriate people, including the director. It was a nice tool to have. It allowed us to get the matte edges the way we wanted and to make color corrections on the set. Plus, we caught a number of problems that way."

As filming on Mighty Joe Young progressed and plates were edited, elements began to arrive at Dream Quest, where the digital team under Dan DeLeeuw had been feverishly preparing for the onslaught of digital work. Some twenty-five shots involving Joe's rampage through Los Angeles and his subsequent heroics on an amusement park pier would be consigned to the digital crew, which had been training on the new software, and was now armed with a working CG model and a hair renderer that had been integrated into Maya and readied for production. "At that time," recalled Casillas, "we started doing animatics on all the CG sequences for the filmmakers– using just a rough gorilla model– so that they could work out timings and blocking for the shots."

In preparation for the character animation task, animators began studying gorilla movement and consulting with Alexander on the nuances of his performance. Beyond the challenges of working with new software, they faced the inordinately complex and often frustrating job of animating not just a gorilla, but a man in a gorilla suit– which entailed a whole new way of thinking. Brought on board to guide the performance aspects of the work– both at Dream Quest and at ILM– was character animation supervisor Chris Bailey. "Chris was the John Alexander of CG animation," observed Yeatman. "His job was to interpret what the director needed in terms of performance, to know what the plate was doing, and to put those two together."

Also contributed by Matte World was an establishing shot that depicted the arrival of patrons at a conservancy event in Joe’s honor. Plate photography consisted solely of limousines pulling up to a red carpet and some practical lighting. Artists digitally fabricated the tent and inserted it into the scene, along with numerous other enhancements.

Goaded by a black market dealer in endangered species, Joe – Alexander in the suit– embarks on a destructive rampage, storming the tent and threatening partygoers.

Assistant art director Douglas Cumming oversees final dressing of a forty-percent-scale tent set. In-camera miniature shots were intercut with Dream Quest bluescreen composites and cuts of ILM’s digitally rendered ape, tracked into live-action destruction footage captured on a full-size set.

Bailey's expertise would also guide animators over a minefield of potential problems that threatened to derail their efforts. "Because CG had the flexibility to enhance Joe's performance, we had to be especially careful not to take the character away from what John had established in the suit," Bailey elucidated. "That meant keeping the animation to that fine line where we were doing gorilla behavior, but we were also caricaturing the man in a suit doing a gorilla. With a guy in a suit– something alive under all those layers of rubber and fabric– there is always ambient movement. Plus, the fur is moving in a strange way, depending on the actor's movement and the wind– just a million things that you'll never get in computer graphics. If you create a virtual Joe at just the level of movement that the suit has, it will only be about ninety percent there, because you are missing out on all the other stuff that tells you it's alive. So in computer graphics, you have to caricature that slightly. John had a rhythm to his run, and his hips were really bouncy, jumping up and down. Whenever he caught his weight, his shoulder would go up near his ear. You had to push all of that a little. I think the level of how far to go above what John did, but still retain his essence, was arbitrary at times, and could be confusing. So I was sort of the arbiter of taste in that regard."

As the story continues, the entourage arrives in Los Angeles, and Joe is transported in a livestock truck to his new home at the nature conservancy. Shots of the disoriented ape peering through the slats of the truck at motorists driving alongside on the freeway were accomplished in-camera with John Alexander in the suit inside a miniature truck. In a shot added somewhat later to more dramatically establish Joe's arrival, Matte World Digital was engaged to create a digital matte painting that enhanced a background plate filmed at a horse ranch in Hidden Valley, which doubled as the sanctuary.

Filmmakers used Blow Joe as a stand-in during the tent shoot.

Cinovation's sitting Big Joe was utilized for a scene in which Jill comforts the traumatized ape in a bunker, where he has been confined following his ill-timed outburst.

Matte World’s first addition to the scene was a foreground rhinoceros, named Mishaki, filmed against greenscreen at the San Francisco Zoo. “The rhino’s handler, Carol Cone, asked us to assemble our greenscreen in Mishaki’s pen several days before our shoot so that he would have time to acclimate to the strange new bright-green color,” remarked Matte World visual effects supervisor Craig Barron. “Rhinos don’t see very well, so they have a habit of charging things in their environment that are new and unusual.” True to form, at one point during photography, the rhino dropped his head and charged the screen, an action fended off by Cone, who threw a few raw potatoes and carrots into the enclosure to distract the animal. “Later, our effects editor, Ken Rogerson, used the head drop to good effect by syncing up that moment just as Joe’s truck travels past, so that it appears as if the rhino is taking note of the new arrival. During part of that take, Mishaki moved off of the greenscreen; but we liked the performance so much that Paul Rivera, our head digital compositor, rotoed the few frames requiring extra matting using Commotion software.”

The black marketeer’s plot to snatch Joe for nefarious purposes runs afoul when the truck transporting the ape overturns on Hollywood Boulevard and the enraged animal bursts free.

For the background, senior digital matte artist Chris Evans produced a digital matte painting to replicate the surrounding conservancy setting. “I took many photographs of the original buildings in Valencia,” Evans said. “Some were used as texture maps, others as reference in painting my digital matte. I also shot various animal habitats from Marine World in Vallejo and the San Francisco Zoo to help me design the shot. I wanted to get that fabricated, man-made look of zoo habitats that would be appropriate to the conservancy setting.” Rivera used Alias Wavefront Composer to match-move and add wide-angle lens distortion to Evans’ digital matte painting and to all the other CG elements created for the shot by animators Morgan Trotter, Brian Ringseis and John Bell. “Those elements included blowing dust emanating from the back of Joe’s transport vehicle, flags atop flagpoles next to the conservatory buildings and distant CG tiger and giraffes inhabiting the preserve– all of which gave movement and life to the background.”

When the truck stops at Joe’s new habitat, a long shot follows the gorilla as he emerges from the vehicle, moves past Jill and spins around beneath a tree. The Dream Quest shot combined a bluescreen element of Alexander in the Joe suit with a plate filmed on the set at the horse ranch. “There was a lot of roto,” remarked Blaine Kennison, “and bluescreens that were hard to pull. We added interactive shadows on Joe as he goes underneath the tree, and a shadow on the truck’s ramp where we could not pull a good enough one from the bluescreen. In general, when we were comping the bluescreens, we’d start out by doing a precomp. ‘Here are the elements you have, throw them together and what does it look like?’ Usually, the first thing was to work on the matte lines. That would take some time. Then we would see if there were any extras we could add,like shadows or glints in the eyes– anything that would help sell the shot.”

Dream Quest relied on its full arsenal of tricks for follow-up scenes in which Joe prowls through traffic on Hollywood Boulevard, causing panic and general mayhem. A wide shot featured Alexander– in the suit against bluescreen – composited into a live location plate.

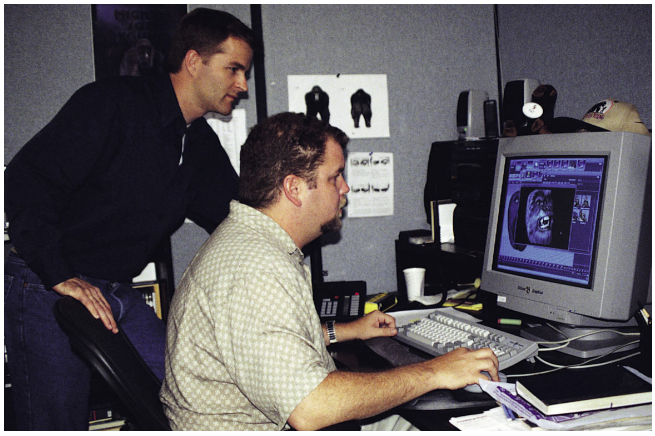
Also pressed into action for portions of the sequence was Cinovation’s quadruped Big Joe.

Joe continues along Hollywood Boulevard, picking up a Cabriolet filled with teenage girls and gently setting it aside. Dream Quest tracked its CG Joe to the live-action, timing the animation to an on-set physical effect in which a real car was hoisted into the air.

During filming of the nature preserve sequences, Mighty Joe Young was marred by a terrible on-set accident. “We were on location in Ventura County,” Underwood said, “when a camera crane platform broke, injuring Don Peterman and camera operator Ray De La Motte. From the very beginning, Don had been totally integral to the production, creating the scheme of how we would pull this movie off.” With both men out of action, the production team had only the long Fourth of July weekend in which to locate a new director of photography. Fortunately, a more than capable substitute was found in the person of Oliver Wood, quickly brought on board to shoot the remainder of the film. “It was a very difficult film to step into like that. Don and I had three months together in preparation; but Oliver and I had only two days.”

Irritated by the persistent wailing of a car alarm, Joe silences it by smashing the offending vehicle. Dream Quest animators tracked the digital gorilla into the live-action scene, timing the animation to sync with a Mercedes imploded on set by physical effects supervisor Allen Hall. The digital character also had to blend seamlessly with intercut composites of John Alexander in the Joe suit filmed on the bluescreen stage.

While at the conservancy locale, Underwood and Yeatman would employ several forced perspective shots with Alexander in the Joe suit. “Our first such shot is when Joe sees his habitat for the first time,” explained Underwood. “He’s in closeup, and behind him the conservancy workers are all looking on as one of their directors, Dr. Harry Ruben– played by David Paymer– attempts to get his assistant to take a photograph of him with Joe. We did another forced perspective for a later segment in which Joe has Harry trapped behind trees in his habitat. It was a shot over Joe’s shoulder, down towards Harry, in the style of Darby O’Gill and the Little People, with John Alexander in the Joe suit placed on risers closer to the camera than he appears.” Additional in-camera shots of Joe in his habitat made use of Baker’s full-size mechanical Sitting Joe.



As a flurry of reporters descend on the conservancy, so do Strasser and his henchman Garth (Peter Firth), who concoct a plan to provoke the gorilla and disrupt attempts to habituate him. Meanwhile, the conservancy directors stage a dinner party on the grounds of the preserve to introduce patrons to their newest resident. For a wide establishing shot in which an unhappy Joe watches nervously as guests arrive for the function, Matte World Digital was again called upon to create key elements of the shot. “We pan off of Joe, who is to the right of the screen in his

habitat," stated Barron, "and establish that there is a waterfall and a moat. The camera continues its pan, taking in the partygoers assembling in a large tent, and ending far left with the arrival of limos dropping off additional guests."

Character animation supervisor Chris Bailey and Dream Quest technical director Patrick Taylor confer on an animation issue.

Since the actual set had already been torn down by the time Underwood conceived of the shot, Matte World Digitally recreated the full environment. "We scouted the horse ranch location in Calabasas first, to determine exactly what the camera would see as it panned from right to left," noted Chris Evans. "Then, with Oliver and Ron on board, we shot the plate photography, which consisted of the limos pulling up to a red carpet on an empty dirt road." Except for the background plate and a bluescreen element of Joe, Matte World would fabricate everything between the bookends of the pan.

First an enhanced tent was created. "Ron wanted a grand establishing shot," recalled Barron, "so we made the tent much bigger than it actually was during the original photography." The tent element was modeled by Brian Ringseis in 3-D Studio Max, with custom texture maps painted by Evans to enhance its overall lighting scheme. At the start of the pan, Ringseis animated bamboo trees blowing gently in the wind behind Joe– real bamboo mapped onto a moving geometry. Then 3-D artist Morgan Trotter created a CG waterfall spilling into a moat, with moving water and moving lights sparkling on the surface. "On the real set, they had lights inside the moat illuminating the waterfall," observed Evans, "so we mimicked that same look of the waterfall and the moat being lit. We also instituted a simulation of light bouncing off the water onto the tent."

Just as Joe, already unnerved by the strange new sights and sounds, is introduced to the assembled guests, Garth sends the gorilla into a destructive frenzy by jangling a metal poaching dog collar– a sound deeply imprinted in Joe's memory from the traumatic night his mother was slaughtered. Spotting Jill in proximity to Strasser– whom he recognizes– Joe clears the moat isolating his enclosure and blasts through the party tent. The sequence, orchestrated by Dream Quest, was accomplished primarily with Alexander in the Joe suit bursting through a fully detailed forty-percent-scale tent, dressed with miniature chairs, tables and champagne glasses. In a nod to the original film, Ray Harryhausen and Terry Moore– the first Jill Young– make brief cameo appearances.

ILM was contacted once again to complete Joe's rampage through the tent with their CG Joe. Using visual cues from composites of Alexander in the Joe suit, technical director Robert Weaver and animator Glenn Sylvester were tasked with lighting the digital Joe indoors– an entirely new twist, as their earlier shots had all been exteriors. In addition, Sylvester had to synchronize the actions of their CG Joe with on-set cues of people and tables flying out of the way. "We had to keep Joe running," Jim Mitchell commented, "while suggesting that if a practical element in the shot moved, it was Joe's arm or leg that did it. Glenn really worked on timing, hitting the marks created in the plate. At the very end of the shot, Joe picks up a guest by his collar and tosses him; so we had to match our CG gorilla's actions to the movements of the actor, who was yanked on wires going up through the tent set. We erased those wires and also added a flying CG chair that Ron wanted in the shot to help tie Joe into the plate."

Subdued by tranquilizer darts, Joe is confined to a bunker cell on the conservancy grounds. While certain portions of the bunker sequence, shot and composited by Dream Quest, would be achieved in-camera with Alexander in the suit in a miniature bunker, several shots featuring O'Hara and Jill physically interacting with the ape were accomplished with the full-size Sitting Joe seated in a corner of a full-size interior set. "There was also some neat bluescreen work in that sequence," observed Yeatman. "Whereas most of our bluescreen shots were foregrounds composited into live-action backgrounds, several establishing shots looking into the caged area from outside reversed that formula. The foreground was the live-action– a motion control pan as Jill and O'Hara head for The Cell door. Then, we replaced a bluescreen behind The Cell bars with the miniature bunker set containing John in the suit."

With Joe's future at the conservancy now in jeopardy, Jill– unaware of Strasser's true identity– accepts his offer to fly the gorilla back to Africa. En route to the airport, Jill at last recognizes her mother's killer, struggling with Strasser and leaping out of the truck cab as it speeds away with Joe still on board. The Dream Quest sequence featured Alexander in the Joe suit, shot from inside a forty-percent-scale truck trailer, rigged for rocking motion on a gimbal at the Playa Vista stages. Background process screens of street traffic were visible through the truck's side slats.

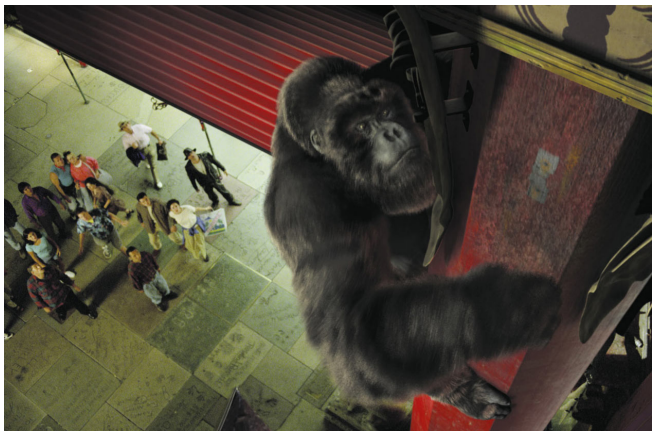
Weaving wildly, the truck flips over at a busy intersection in the middle of Hollywood Boulevard. Joe punches through the trailer, jumping out and landing atop a nearby Camaro. Intercut with shots of Alexander in the suit for scenes of Joe's escape and rampage through Los Angeles was Dream Quest's CG Joe– making its first appearance. For the sequence, animators tracked the CG character into the background plate, matching the shake of the car as the gorilla lands on its roof.

Ambling down Hollywood Boulevard, Joe approaches a Mercedes whose car alarm goes off, prompting the unnerved ape to smash the vehicle's hood. Physical effects supervisor Allen Hall rigged the Mercedes to implode on cue, while on the bluescreen stage, a blue cutout of the car was set up for Alexander to mime the action. The series of cuts presented Dream Quest with its most complex matching sequence involving the CG character. "We cut from a rear-view shot of John smashing the car to a front shot of our CG Joe finishing off the smash," said DeLeeuw. "It was a real challenge to match our CG animation to John's movements in the suit and to the facial articulation." DeLeeuw and his team also had to create a believable shadow for the CG figure. "We made a CG version of the Mercedes and tracked that to the real one so we could cast Joe's shadow on our CG vehicle, then composite both Joe and his shadow over the top of the real Mercedes. We also deformed our CG car the same way that the real one deformed."

Next, Joe crosses the street and lifts a Cabriolet full of young girls, setting it aside like a picnic basket. Hall rigged a real Cabriolet– hoisting it into the air and moving it off to the side– while Dream Quest animators timed the actions of their digital Joe to the physical effect. Continuing on his way, the errant gorilla attempts to cross the busy boulevard, leaving a jumble of wrecked cars in his wake. Plate photography for the scene was filmed over a period of five nights. First, the action was staged in slow-motion with stunt drivers, precision drivers and extras rehearsing their reactions. Several run-throughs with Blow Joe enabled Oliver Wood to light the character

appropriately. One take with Blow Joe was recorded for reference; then the background plate was photographed utilizing a system of counts to time individual reactions. Dream Quest surveyed the entire set and scanned it down to forty percent to provide a virtual blueprint for the insertion of a bluescreen Joe.

On stage at Playa Vista, a ramp was erected parallel to the bluescreen and Alexander in the Joe suit filmed walking across it. “Three car crashes– which had been staged by Terry Leonard, the stunt coordinator– occurred during the cross,” noted Tom Jacobson. “So we needed Joe to react to a crash at just the right moment, three different times.” A low-tech approach was used, with a count system and markers to time the action. “We came up with a certain speed for John to cross and react. Looking at the plate on a video monitor, we called out the crashes into a sound system, recording the audio so that it was consistent every time.” Once Underwood, Yeatman and Paul Hirsch had chosen the optimum take for the background plate, Dream Quest assembled a rough Avid composite with all nine takes of the Alexander bluescreen action. Then they did a clean composite with the selected take, rotoscoping all of the cars that crossed in front of Alexander.



As an astonished crowd gathers below, Joe scales the glittering facade of the Chinese Theater, smashing a neon-lit pagoda along the way and breaking off an ornamental mask. In addition to its digital ape, inserted into location photography of the actual theater, Dream Quest had to manipulate the plate considerably, adding breakaway CG set dressing to the landmark structure.

As Joe approaches Mann's Chinese Theater, he sees both the glittering movie palace and the landmark 'Hollywood' sign visible behind it. Since the real sign was situated a mile or so east of the theater, Matte World Digital was called upon to relocate it into a more pleasing configuration. Digital matte artist Brett Northcutt captured still daytime images of the hillside sign for the nighttime sequence, since the sign is never lit up at night. "The shot starts down on the street, and we tilt up to reveal the theater and the sign," recalled digital compositor Todd Smith. "Since the plate was shot static, we put lens distortion on it so as we tilted up it wouldn't look like it was just a pan-and-scan frame push." Simple sky gradation and stars were then added to the scene. "I didn't want to have the moon and hundreds of stars when, in every other shot, it was a black sky," commented Northcutt, "so we just introduced a bit of a sky using Amazon Paint and Photoshop to set off the mountain and the sign."

Dodging traffic, Joe crosses a busy freeway in an effort to reach an amusement park beacon that he misconstrues as a signal from Jill. The ILM CG Joe was utilized for the sequence, with animators creating wire-frames of cars in the plate in order to track their movement through the scene. The digital gorilla was then inserted into the environment, together with shadows and reflections.

Pausing at the theater, Joe begins scaling its ornate facade. As he climbs, his foot smashes a pagoda with neon across the top. "On set, we timed it out and turned off the neon in the spot where we thought our CG foot would land," said Dan DeLeeuw. "Effects animator Chris Biggs added sparks at the point where the neon tube shatters." An aspect of the digital performance conceived after the plate was shot featured Joe breaking off an ornamental mask atop a pole as he climbs. "We created a CG mask for him to break, but there was a real mask that was already in the plate photography. Instead of having to paint it out by hand, we replaced the pole with a CG pole. Then we decided to replace a ground-level ticket booth and canopy that ran across the back of the shot. So in addition to matting Joe onto the pole, over one-third of the side of the shot is all CG."

Tearing through the nearby hills, the gorilla next stops at the Hollywood sign, where he peers through the giant 'O,' catching sight of an amusement park searchlight on the horizon that he mistakenly interprets as a signal from Jill. The shot included a background view of the city contributed by Matte World Digital. "We couldn't find the perfect exposure to make it look exactly like the image of the city we wanted," said Craig Barron, "so we fabricated the entire background as a digital matte painting." Composited into the shot, together with Dream Quest's foreground bluescreen element of John Alexander in the suit interacting with a miniature Hollywood sign, was the image of the Los Angeles basin at dusk, fabricated by Brett Northcutt from a series of still photographs he shot at the Griffith Park Observatory,both at night and again at dawn to achieve clearer detail in the buildings. Jon Bell created a CG helicopter, which can be seen on the horizon tracking Joe with its own searchlight beam– two separate elements composited by Goeff Richardson. To further enhance the shot, Brian Ringseis created hundreds

of CG car headlights moving on distant freeways. Lastly, Morgan Trotter, working in Amazon Paint, realized the primary search beam. A pair of sister shots– one viewed through the 'O' and another closer shot that occurs after Joe climbs through the giant letter of the sign– were composited by Todd Smith with a moiré effect added to the matte painting so that the background city lights appeared to shimmer.

Next Joe cuts into traffic on the San Diego Freeway, dodging the onslaught of cars and eventually running off the road. Two CG Joe shots in the sequence would present yet a third unique lighting setup for the ILM digital gorilla. "For the freeway sequence, we were outdoors at night with a helicopter spotlight on Joe and strong shadows from above," recalled Jim Mitchell. "We added dust and had to color-correct the shots to achieve a proper lighting balance." Steve Nichols and Daniel Jeannette animated the shots, with Eric Texier providing technical direction. "After producing wire-frames of the practical cars so we could track them, we put Joe into the freeway environment," noted Jeannette. "With that match-move information we were able to trust our virtual environment, using the wire-frames to cast shadows and reflections." After ILM's tight shots of Joe, the scene cuts to a more distant overhead view of CG Joe on the freeway, realized by Dream Quest.

As the camera pans from the freeway to the searchlight, the pier amusement park comes into view– an image enhanced with another Matte World painting. "The trees behind the freeway were illuminated well enough by production so that we could see the branches," commented Barron, "allowing us to make roto mattes for our digital matte painting background; but the trees ended up looking too bright matted over the new night sky and background. We didn't want to make the painting brighter because it wouldn't look like nighttime; so we went back and made more mattes to make the trees darker. Morgan Trotter created the volumetric CG beams using 3-D Studio Max. Production gave us the exact degrees per minute that the practical searchlight rotated; and we matched that, creating a core light and a second beam for a glow element."

Trotter also created a moving CG Ferris wheel seen in the distance. "The Ferris wheel was modeled in two halves based on video references," noted Trotter. "The lights on the half closest to us were volumetric lights animated in a sequence. I rendered the light hitting the surface and used that on the back half of the Ferris wheel so I didn't have to have two sets of lights." As a final element, a CG freeway railing was built and matched into the shot. "We had to add that since, in the next shot, you see Joe climb over it," explained Paul Rivera. "I matched in the rest of the painting behind the trees, after Brett Northcutt provided me with a matte isolating the foreground area."

Conceived and planned as an additional story element after principal photography on Mighty Joe Young had wrapped was a sequence in which Joe, having been spotted on the freeway, is pursued by two police helicopters into a flood canal. "By making things a little more perilous for Joe through a strictly visual action sequence in which he is pursued like a fugitive through the city," observed Underwood, "we could enhance the audience's emotional connection with him. David Vogel and Joe Roth at Disney were incredibly supportive, and said: 'Yes, that sounds great. Let's do it.' It was wonderful to be able to go back– knowing what we now knew about

shooting Joe and about what worked from our original photography– and tailor-make something that was both economical and effective for the final chase, winding up at the amusement park."

As the chase begins, the aircraft– a Huey police helicopter and a Jet Ranger– pursue Joe through the brush leading to a flood control channel. Running along the wash, the ape evades their gunfire and picks up speed until, at an overpass, he jumps down, grabbing onto a long pipe under the bridge and swinging into the water. On a stage at Disney's Burbank studio, art director Tom Southwell built a forty-percent miniature canal representing a section of the river basin. "Everything except for the one shot where he jumps down and swings under the overpass was John in the suit," said Underwood, "mostly in-camera shots done on stage. It was fun to be able to shoot in any direction with John in the suit." Real helicopters, filmed on location in City of Industry would later be inserted into the shots.

For the shot of Joe jumping into the water, ILM's digital ape was pressed into action, animated by Doug Smith. Digital artists also painted out practical elements on the underside of the bridge in the plate photography and produced their own CG pipes attached to a CG bracket that breaks as Joe swings out with the full force of his weight. An additional practical splash element was composited for the watery touchdown. "We actually shot it as wide as we could," Jim Mitchell elaborated, "but to some degree we were guessing where Joe was going to be. We later realized that at a certain point our image needed to be tilted down a bit more to fit Joe in the shot; so we had Cathy Burrow, our paint artist, extend the side wall further down to expand the whole shot. Technical directors Amanda Ronai and Jeroen Lapré enhanced the image by creating a backlighting effect on Joe, matching it to the practical Joe in the plate." A subsequent high-angle shot of the wash was executed by Dream Quest as a split-screen effect, using a location plate captured from a crane and replacing half of the image on one side of the overpass with the miniature wash.

At a pivotal point in the chase, Joe slogs through the water toward camera as both helicopters round a corner and begin bearing down on him with spotlights. Yeatman opted to get the shot using motion control and fifth-scale helicopters modified to work on the stage at Dream Quest. Duplicating Oliver Wood's live-action lighting, each helicopter was captured as a separate element, mounted on a motion control rig and shot in multiple passes for lighting and smoke. To increase the dramatic impact of the shot, Underwood used a hand-held camera placed very low to the ground, rapidly tracking in front of the ape as he ran. "We surveyed the forty-percent wash set that was built on stage at Disney," said Yeatman, "and CG effects animator Chris Biggs used witness-point tracking to construct a 3-D virtual version of the set and the camera. Motion control director of photography Scott Beattie then took the unsteady hand-held tracking motion from the set and plugged that in on the motion control stage. After we shot our helicopters, with the tracking producing this apparently unsteady plate, the two pieces of film were put together– and it looked like one steady composite since the model helicopters were bouncing up and down in perfect sync with the original camera element."

Unable to locate Jill at the source of the beacon, Joe whacks the amusement park searchlight in frustration. A foreground element, with the suited Alexander on a miniature blacktop surface reacting to a searchlight, was composited by Dream Quest into background footage of the full-size amusement park set. Added to the shot was a CG light beam and intricate shadows playing over the ape from a nearby carnival ride, an illusion created via a tabletop miniature of the ride.

A heroic effort by Joe saves the life of a young boy trapped in a gondola atop a burning Ferris wheel. Hanging precariously from the structure– a full-size Ferris wheel at the Long Beach location– Dream Quest's CG Joe protectively cradles a CG replica of the youngster in the crook of his arm.

For another view of Joe trailing away from the helicopters, Matte World expanded the miniature setting, adding additional elements above the flood channel walls. Chris Evans took still photos of buildings, telephone poles and floodlights in back alleys, and used digital painting tools to alter their color and contrast scheme to fit them into the scene. Digital artists were also tasked with extending the flood channel walls. “We created the water at the bottom of the channel, plus the reflections of the walls,” commented Evans. “We were on set when they shot the plates, so we were able to suggest camera angles to help us double the perspective of the width of the set when we added our digital matte elements.”

Drawn to the amusement park by the brilliant Klieg light– an upright old-fashioned searchlight on the pier– Joe finds, unhappily, that it is not a signal from Jill. Underwood wanted the gorilla to approach the light and whack it, out of frustration. “Although we had an actual Klieg light, we shot the background plate without it, with people screaming and running away from an empty area,” explained Yeatman. “We wanted to replace the entire foreground in the shot with a bluescreen insert of John interacting with a miniature Klieg light. To the left of the scene was a Yo-Yo ride casting a wonderful shadow over the foreground area; so we had to add a miniature shadow as well. When we eventually got to the bluescreen stage, we built a large tabletop miniature, and made little cutouts that we lit to create the illusion of shadows from the ride. For the composite, we put the split underneath a yellow guard rail separating the foreground from the ride in the plate so that one side was real shadows and the other side was miniature.”

In-camera closeups were achieved with Big Joe and a full-size mechanical gorilla arm, built by Cinovation.

Scattering the crowds as he prowls the pier in search of his friend, Joe wanders through a funhouse Hall of Mirrors. The signature shot, which featured an extreme closeup view of the CG gorilla exiting the Hall of Mirrors, would put the digital artists at Dream Quest and their Yeti hair program to the ultimate test. “Joe just stands there for a few seconds,” recalled Chris Bailey, “and you get a real good look at him before he walks by camera. His feet are surrounded

by mist, his reflections are cast all over the walls in the Hall of Mirrors. There are a million things that could make that shot look like CG. And it doesn't. The real challenge was the fur. Because he was moving so slowly, motion blur couldn't hide anything. The jiggle that happens in the real suit when Joe smacks his fist down as he walks had to be caricatured just right; and the balance between the inertia on the hair– which causes individual hairs to flop around– and the skin jiggling up and down had to be right on the money. In early tests, it was either too bouncy or not bouncy enough; and getting that just right was a very time-consuming process. Also, since Joe is walking by camera, you see his face clearly. It was very important that his face not only look like the rubber suit head, but actually behave like it. His lips open and close as he breathes; and when his mouth closes, that little bit of rubber compresses ever so slightly. It's nothing anyone will notice; but if it wasn't there, his face would look like it was made of porcelain. It was a very delicate shot."

Further complicating the shot was smoke in the background plate, emerging with Joe from the building. "The smoke had to be recreated on top of our digital Joe so that he looked like he was coming through it," said Blaine Kennison. "Adolph Lusinsky, who lit the shot, rendered the front feet separate from the back feet so we could get the depth of the smoke that Joe's standing in, which was also put into each mirror reflection." In addition to those elements, shadows underneath Joe's feet and arms– casting toward camera due to backlighting– had to be composited into the shot. "There are maybe ten other fix-it elements in that shot, although most people aren't even going to notice them. We try to get it ninety-five to ninety-eight percent correct through animation and lighting; but there are always cleanups and final adjustments that have to be made."

Having tracked Joe down, Strasser, armed and out for blood, gets more than he bargained for when Joe intercepts him and flings him from the pier to his death. The sequence was accomplished with Alexander in the suit miming the action, and a CG Strasser, created by Dream Quest. For the digital human, Dream Quest scanned a lifecast of Rade Serbedzija and took photographs of the character's wardrobe. "Bruce Wright built the CG figure using the same texture and lighting processes we had used to create our CG Joe," observed Dan DeLeeuw. "We added a skeleton inside his basic anatomy; but this time, rather than hair, we had clothes to animate."

Though Strasser is dead, his earlier actions have set off a series of explosions that engulf the nearby Ferris wheel in flames, requiring the hurried evacuation of children on the ride. O'Hara and Jill, struggling to get Joe off the pier before the arrrival of authorities, notice one lone boy still atop the burning ride. In a selfless act, Joe climbs the Ferris wheel and pulls the child to safety just moments before the structure's collapse. The rescue required the interaction of Dream Quest's CG Joe with a CG version of the boy, inserted into plate shots of a full-scale Ferris wheel, filmed at an amusement park set in Long Beach.

Working with a group of five, Rob Dressel oversaw animation of the Ferris wheel rescue scene using a digitally recreated 3-D set. "Hoyt and Ron selected their preferred live-action camera angles and shots," Dressel related. "Then we placed our CG Joe in each scene based on our tracking of the real Ferris wheel, and created laser printouts for each shot– both an overhead

and elevated view– so that Hoyt could be sure we were placing Joe in the correct part of the wheel. We did the same thing when we added fire effects to all of our Ferris wheel shots.” l

When the blazing Ferris wheel topples, Joe plunges to the ground, injuring himself in the fall but releasing the boy unharmed. A shot of the prostrate gorilla, surrounded by onlookers and comforted by Jill, made use of yet another full-size incarnation of the ape constructed by Cinovation.

The sequence begins with CG Joe composited into a motion control plate shot at the base of the Ferris wheel. Tearing down the protective railing, Joe jumps onto the platform and begins climbing. Dream Quest built a CG railing for the scene, along with a CG section of Ferris wheel with the ape's shadow cast on it. As Joe steps up onto the wheel, a digital warp on the metal structure beneath him was added to simulate the stress caused by the weight of the oversize gorilla. "We warped the parts of the wheel Joe interacted with using Elastic Reality," explained DeLeeuw. "Chris Biggs added decorative lights breaking off and falling, and sparks shooting as he steps on them."

On set, Rick Baker and his puppeteering crew prepare the animatronic creation for its big scene.

A trail of fire flares upward, chasing the gorilla further up the wheel and cutting off any possibility of retreat. "That was shot in separate passes," related DeLeeuw, "one for the background plate and another for Allen Hall's fire effect. As an extra touch, we added a heat wave element– ripples in the background that we created in Composer. We provided the software with a gray-scale image that displaced the surrounding pixels, giving the image a ripple distortion." Dodging fire and explosions along the way, Joe finally reaches the gondola where the terrified boy is trapped. Shots around the gondola were executed both with Alexander in the Joe suit, interacting with a miniature section of Ferris wheel, and with the digital Joe. For several in-camera shots on an amusement park set, the mechanical Big Joe was utilized, surrounded by smoke and framed against a black sky. A shot of the ape pulling the boy from the gondola was realized with a full-size mechanical Joe arm grabbing the youngster.

Returned to the wilds of Africa by a sympathetic public, Joe– a bluescreen stage element with John Alexander in the suit– looks on contentedly as Jill and O'Hara embrace during the film's closing moments.

On the ground, a further explosion rocks the burning structure, causing Joe to lose his footing. The CG Joe and a CG boy were featured in the shot and in a followup view of the gorilla hanging by one arm atop the Ferris wheel, the youth cradled in his free hand. Moments later, another blast jars the structure, and it begins to topple. Joe clings to the wheel most of the way down, leaping free at the last possible moment. A closeup of the ape falling away from camera was captured as a bluescreen pickup at Dream Quest, with Alexander in the suit composited into a background plate of the amusement park. For a wider view of the jump, Alexander was replaced by his CG counterpart, while a shot of his landing reverted back to the ape-suited performer. A final view of the injured gorilla lying on his back was filmed using the full-size Dead Joe, articulated by Baker and his puppeteering crew on location.

Mighty Joe Young concludes with an epilogue in which Jill, O'Hara and Joe are seen happily ensconced back in their jungle paradise. A nearly 360-degree helicopter shot reveals the reinvigorated ape running full-tilt across an open field of moving grass. The closing shot– a full 660 frames– was consigned to ILM's CG gorilla. "Aside from the fact that this was a long, computationally expensive shot," remarked Carl Frederick, "there was another potentially bigger problem. Since the background plate was a helicopter shot over a largely featureless field, it had been filmed with a horse and rider galloping across the plain for the cameraman to track– the idea being that our digital Joe would simply cover them up. Unfortunately, due to the constraints of animation and the relative sizes of the horse and rider, that approach didn't work; so we had to digitally remove the unwanted element from every frame of the sequence. Our solution to get rid of it was to find other frames in which the same region of field was not concealed by the horse, and warp and blend them into position over the animal. This required careful tracking of landmarks and a superb image warping system implemented by Rod Bogart, Linda Siegel and Scott Stewart. In addition, the horse was so large in frame for part of the sequence that the track/warp method did not always work. So Terry Molatore, Pat Jarvis and Cathy Burrow were saddled with painstaking touch-ups or wholesale replacement of large portions of many frames. The result is a masterpiece of tricky animation, fur rendering and invisible plate reconstruction."

Certainly for Rick Baker and Hoyt Yeatman– and more than likely all who labored to re-create Mighty Joe Young for the enjoyment of modern-day audiences– the experience was an unforgettable one. For Baker, it was the crowning achievement of a lifelong interest in gorilla character creation. "One reason I wanted to do this show," Baker reflected, "was that I was hoping with Joe, we could make a movie that was at least close to the original. And I wanted to create a better gorilla than we had ever done before. This time I had the freedom to do that. Joe is definitely the suit I've always wanted to build."

Yeatman's simian fascination was longstanding, as well. "The original Mighty Joe Young was one of the seminal films of my childhood that got me interested in doing visual effects," Yeatman revealed. "My mentor is, and always has been, Ray Harryhausen. So by taking part in the remake of a film that gave Ray his big break in the industry, I feel as though I've come full circle." Fittingly, during the two years it took to make the movie, Harryhausen visited Dream Quest twice to check out the work in progress. "The first time he came, we were in the midst of creating our digital gorilla. I think he was quite skeptical of the whole affair. He seemed impressed by CG, but wasn't really sold on the idea that a computer could effectively produce a warm, nonscaled creature like Joe. The second time he came, though, we were well on our way to completing some shots, and he was just blown away by what both ILM and Dream Quest were producing as finished product. We suggested he try his hand at animating something. After hesitating for a moment, he picked up the mouse and started moving it around. And the biggest smile lit up his face."

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image

THE SWEET HEREAFTER

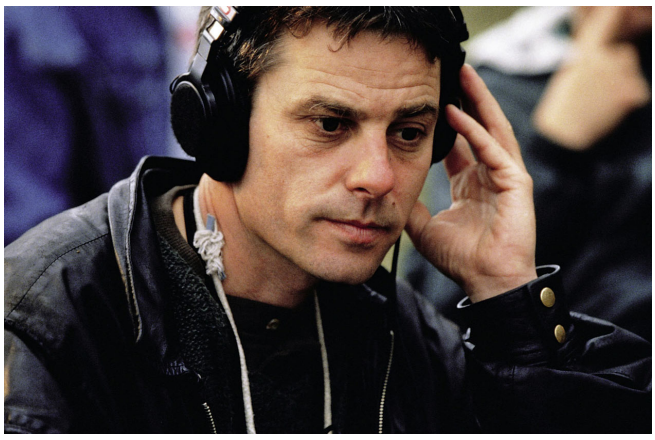
ARTICLE BY Kevin H. Martin

Some early reviews of 2001: A Space Odyssey derisively dismissed it as the first big-budget art film– which, in some ways, it was. But many youthful moviegoers embraced its signature "Jupiter and Beyond the Infinite" segment for the intensely subjective experience it yielded, often choosing to enhance their responses through the use of hallucinogenics. Metro-Goldwyn-Mayer picked up on the trend and created a follow-up ad campaign aimed at this emerging demographic, marketing the film anew as "The Ultimate Trip."

What Dreams May Come– a PolyGram Films release and an Interscope Communications/ Metafilmics co-production– mirrors 2001 in that it too fits the big-budget art film niche while depicting vistas never before seen by man. Dealing with a different kind of 'ultimate trip'– the nature of the Afterlife– the story follows the lives of Chris Nielsen (Robin Williams) and his wife Annie (Annabella Sciorra), a couple whose deep love is tried by the tragic deaths of their children. After Chris is killed in a car accident and his consciousness enters a heavenly paradise, Annie commits suicide rather than face life without him. The love of these two soul mates manages to transcend even those events, with Chris willingly making a descent into Hell to save Annie from damnation and an eternity of suffering.

The unconventional love story was based on a novel by Richard Matheson, a writer who published scores of horror and science fiction tales in the fifties and sixties, while also penning many episodes of the original Twilight Zone television

In What Dreams May Come – a PolyGram Films release based on the Richard Matheson fantasy novel– pediatrician Chris Nielsen (Robin Williams) dies with shocking unexpectedness and soon thereafter finds himself, quite literally, in a paradise of his own making. One of his guides in the Afterlife, the beautiful and mysterious Leona (Rosalind Chao), sets sail with Chris on a voyage of discovery.



To realize his unique cinematic vision of Heaven and Hell – and the spiritual odyssey of a man undeterrable in his compulsion to be reunited with his soul mate– director Vincent Ward relied upon imaginatively stylized interior sets and the natural beauty of Montana locations, juxtaposed and

innovatively enhanced by digital artists at Mass.Illusions, Digital Domain and POP Film.

series. His print and screen work continued with the story and teleplay for Duel, a TV movie that helped catapult the career of a young director named Steven Spielberg. Matheson's body of work also influenced the current generation of horror writers, serving as inspiration for several of Stephen King's tales.

In the late seventies, while prepping Matheson's Somewhere in Time for filming, producer Stephen Simon became enchanted with What Dreams May Come and convinced Matheson to write a screenplay adaptation of the story. In the ensuing years, director Wolfgang Petersen and high-profile companies such as Lucasfilm and Amblin Entertainment expressed interest; but it was not until Rain Man screenwriter Ron Bass produced a new draft that the project acquired a director– Vincent Ward– and found its way back onto the production track.

A trained painter before turning to film, Ward had a striking visual style– first showcased a decade ago in a New Zealand-made picture called The Navigator: A Medieval Odyssey– that would lift Matheson's story right off the page and into a decidedly cinematic realm. One of Ward's story contributions, which would significantly influence the film's depiction of the Afterlife, was to transform Annie from the housewife character in Matheson's novel to an artist. "Richard Matheson had used verbal metaphors in the novel that related to painting," observed Ward, "so I decided to make Annie a restorer of 19th-century art, and a painter in her own right. As the depiction of Paradise was one of that time period's principal concerns, this artistic vision would directly influence her dead husband's notion of an afterlife, while at the same time allowing us to access the era's vast art riches."

Visual concepts for Ward's hereafter– a world literally made up of brush strokes and gobs of paint– would rely heavily on 19th-century art influences that ranged from German Romanticism to a stained-glass form of Impressionism. "I started sorting through references four months before anyone else came aboard," said Ward, "in order to provide very specific concepts to the art department and the effects houses. I would explain to them what I liked about each element, whether it be the kind of paint strokes used or the color of the sky. That was very useful– on a project this size, I didn't have the time to paint every image and do each piece of design work myself."

While a general look for the Afterlife had been conceived, the means by which that concept would be captured had yet to be determined as the film's development phase drew to a close. "Realizing the Painted World was something I didn't know how to achieve as we went into this project," Ward admitted. "The project had a 'walking on water' feeling initially, because there was a fair chance that we would sink." Early ideas for creating the Painted World included a straightforward matte painting approach– an idea Ward rejected. "That approach failed to expand on what had been done before. More importantly, it didn't really capture the concept."

The breakthrough came during a meeting between Ward and Mass.Illusions visual effects supervisor Joel Hynek, who suggested a digital solution. "We approached Vincent Ward with the notion of attaching 2-D and 3-D objects– in this case, wet or dry paint strokes– to moving scene features," stated Hynek, "matching both the motion and spatial changes made by those features through the duration of each shot." This untried technique would require the development of an

image-based paint animation software– dubbed Motion Paint– as well as a pair of methodologies to compile tracking data. “One would be used on location, while the other would be a post process. These were essential, since most of the film would be shot without motion control. The basic premise was to use Motion Paint for the transformation of wild-shot main unit photography.”

While Ward liked the idea immediately, it remained for Joel Hynek to convince the film’s producers. A Painted World test – staged outside Ashville, North Carolina, in October 1996, and recorded with a Steadicam– consisted of a single panoramic landscape, plus a setup featuring a performer moving through foliage. The latter allowed for plenty of interaction between actor and environment, with the performer brushing up against bushes and traipsing through a dense environment that would have proved far too complex to articulate utilizing traditional rotoscoping techniques. This wild location test footage was then tracked to facilitate the integration of the digital painted world– a task aided by the fact that lidar (laser-based radar) had been utilized on location to capture range data on the objects in the scene. The lidar scans were registered and merged to create a cloud of points resembling a 3-D radar image, and this information was then sorted by object type to identify various scenic features.

Tracking the location footage would require more than just lidar, however. Mass.Illusions visual effects supervisor Nicho- las Brooks had experience with various approaches to motion estimation using Machine Vision algorithms– the same technology used to spot flaws in automated assembly processes. “If there were a lot of bold 3-D shapes to scan on location,” commented Brooks, “then the lidar process would work just fine. But in order to tell what the camera was doing, Machine Vision techniques became the key to analyzing photography for motion reconstruction.” A form of image analysis– derived from artificial intelligence research conducted over a decade ago– Machine Vision could determine each separate motion vector for every feature contained within an image, then extract the relevant geometries of scene details and resolve range data. The resulting sequence motion map would allow Mass.Illusions artists to determine the proximity and movement of bushes, trees and water in 3-D space. Once the test shot was tracked, the earliest version of Motion Paint– developed by technical supervisor and effects developer Pierre Jasmin– was deployed, permitting actual scanned-in brush strokes to be attached to scenic features in the North Carolina plate photography.

The test more than amply demonstrated the inherent possibilities of Mass.Illusions’ suggested methodology for the film, and was instrumental in securing a greenlight from PolyGram. “Mass.Illusions’ approach was extraordinary,” said Ward. “After that successful test, we spent the next year and a half building on and refining their processes.”

“After production bought off on the look,” Hynek explained, “they wanted us to take it further. That created new questions. Which direction? More 3-D, or more painterly?” The concept underwent considerable refinement in the following months, especially since Ward required that the look of the environment vary in accordance with his lead character’s emotional state. To guide the process, Hynek made up a continuity graph depicting the degree of ‘painterliness’ in each shot. “It wound up looking like the silhouette of a two-humped camel. When Chris first wakes in the Painted World, the painterly effect undergoes a pronounced spike. Then it settles as he realizes that this reality is his wife’s painting come to life. The effect peaks again as he

goes toward their dream cottage, then subsides once more. In the less painterly shots, there is more 3-D, the realization of a virtual environment. But when the brush strokes were broader and the images more painterly, the environment would seem more 2-D."

With the production based in the San Francisco bay area, set construction commenced at two former naval bases– Alameda Point Naval Air Station and Treasure Island– where abandoned aircraft hangars were converted for use as shooting stages. To establish the natural beauty of heavenly Summerland, as the Afterlife paradise came to be called, Glacier National Park in Montana was selected after the director's preferred locale– the Swiss Alps– fell prey to budgetary limitations. Certain production design elements were locked in when the location shoot commenced, dictating the colors used for dressing sets and locations. "To create Summerland in Montana we used up one of the largest greens-and-flowers budgets anyone's ever seen," noted visual effects producer Ellen M. Somers. "But even at that early point we knew there were some aspects of the location that did not work and would have to be addressed in postproduction." Even unembellished, however, the spectacular Montana landscapes offered producers– nervous about the Painted World effect– a measure of comfort. If the effect failed, some reasoned, the beautiful natural background could serve as Paradise without postproduction enhancement.

Among the tools employed on location in Montana was a modified version of the lidar system that had been used for the Painted World test. "The camera looked like a mini-bazooka," Nick Brooks noted. "It was this long thin tube we could set up anywhere. From a mountaintop the laser could scan for more than thirty meters, collecting data on every object that interrupted its beam. We moved the camera to get different points of view, then registered those various views together in order to build up a three-dimensional database of the terrain."

Refusing at first to accept his demise, Chris lingers in the real world, unable to see his first spirit guide, Albert (Cuba Gooding, Jr.), as anything but an unfocused presence trying to wrest him from all that he holds dear.

When the camera was in motion, however, reconstruction data was extracted, using Machine Vision, prior to the match-moving of 3-D scene files. "Normally," Brooks observed, "when you're placing an object within a live-action scene, your tolerance is only concerned with the area where CG contacts the real terrain. But we had a bigger problem, since every aspect of the element had to be grounded. To achieve this, we performed a by-hand motion track, using a standard 3-D camera reconstruction package– and that got us eighty percent of the way there." An automatic process then fit the 3-D elements into the image, attaching

them to scene details within frame. “Motion Paint would take into consideration the optics of the main unit camera and reproduce the lens barrel distortion on our virtual camera. That made tracking much easier.”

The out-of-focus spirit effect was created at Digital Domain, where image-warping and distortion techniques were employed to blur the live-action form of Gooding– extracted from greenscreen material on set or digitally rotoscoped from the plate photography.

At the same time Pierre Jasmin was completing his Motion Paint test shots, senior software developer Peter Litwinowicz was about to publish a paper on a related process he had developed while at Apple. “Six months before leaving the company,” Litwinowicz recalled, “I began investigating how to paint video images. By performing what I called ‘dense tracking’ through the video, I found that paint strokes could remain attached to an object and follow it through the sequence. This contouring prevented it from reading like a shower-door filter effect.” Litwinowicz soon joined forces with Jasmin to refine the image-based paint animation software and also address a variety of unresolved issues. “There were problems getting the paint particles to stay attached to a live-action character, plus general matters of conformance to live-action. A tree still has to resemble a tree, regardless of what your universe is made from.”

Motion and color-capture issues arose for shots featuring actors and foreground objects that occluded the background when the camera was in movement. “We had to be able to identify, track and follow every aspect of the image,” Litwinowicz stated. “This was absolutely essential because the background element had to come back into view after being eclipsed. The computer could track pixels and objects in the scene through an array of Machine Vision tricks. One of these was making the system recognize that fast-moving objects are generally closer to the camera. While that’s not always true, it was one way the data could be utilized. A lot of what gets developed in the research community– and winds up in standard software packages– is a kind of Machine Vision that tracks one particular path. But if you’re trying to follow pixels in a scene with actors crossing in front of scene details, such a system might switch over and follow the actor in mid-move. We had to find a way to recuperate from that problem. One of the ways we dealt with breakage was by developing a lot of interactive fix-it tools, so our artists could identify these errors and put a stop to them. It was by no means a fully automated process.”

One of the unique characteristics of the Painted World was the interaction between actor and environment. Chris Nielsen would brush up against a bush, for example, and paint would stick to his arm as he swung it forward. “Since we were working somewhere between 2-D and 3-D,” said Litwinowicz, “there was plenty of latitude when it came to mixing elements together. We could take the motion from Softimage-created objects and use that to generate motion to mix with the wind on location, for example. Or there could be a real plant blowing in the wind, and that real motion could be applied to a CG object. We could also dial in the degree of motion. We’d take motion from different sources and put them together; and you couldn’t tell if it had been sourced from live-action or reconstructed.”

A principal tool in the creation of those CG objects was the VPLA (visual programming language for animation) software created by Wayne Lytle in concert with the Cornell Theory Center while he was a member of its visualization group. More than six years in development, this procedural 3-D system– a kind of Dynamation-meets-Prisms– uses both modeling primitives and advanced

particle systems to construct new elements and choreograph their motion. On What Dreams May Come, VPLA was licensed by Mass.Illusions and developed further in a joint effort with Lytle and software researcher Jeremy Yabrow. VPLA was used to create fully synthetic plants and bushes that interacted with the genuine environment, even to the point of being blown by the wind present in plate photography. The system hooked up with Softimage, allowing rendering via either Mental Ray or RenderMan. “We employed it often to perform a kind of virtual horticulture,” said Nick Brooks. “The art department had dressed many of the environments with silk flowers, but we added a lot of CG flowers and vines, as well.” Though 2-D elements were used extensively throughout the Painted World to fill out backgrounds, 3-D digital matte paintings were also created to enhance or replace Montana plate imagery.

With both concepts and processes in place to produce the Painted World, the next goal was finding people capable of doing the work. “When creating a series of paintings,” said Ward “you normally face the canvas alone. But on this film hundreds of artists were involved. My collaborators had to possess a rare combination of traditional painting and CGI experience– and those qualities maintained the unity of the vision.”

Locating such artists was a considerable undertaking, and required a lengthy search. “I’ve done a huge amount of recruiting previously,” Ellen Somers stated, “but this was among the most difficult assignments I’d taken on. The type of eye and understanding called for went so far beyond what you look for on a typical resumé. This show called for a painter’s understanding of art– his mental tool set, if you will– just to approach a shot. At the same time, the technical knowledge necessary to communicate with the software department had to be there, too. It became a real needle-in-haystack search.” To deal with both creative and technical aspects of the show, four CG supervisors were ultimately engaged from three outside companies: Mike Schmitt of Giant Killer Robots joined the team during the previsualization phase and later served as 3-D supervisor, while Scott Gordon and Peter Travers from ShadowCaster, along with Karen Ansel of Mobility, all came on in postproduction.

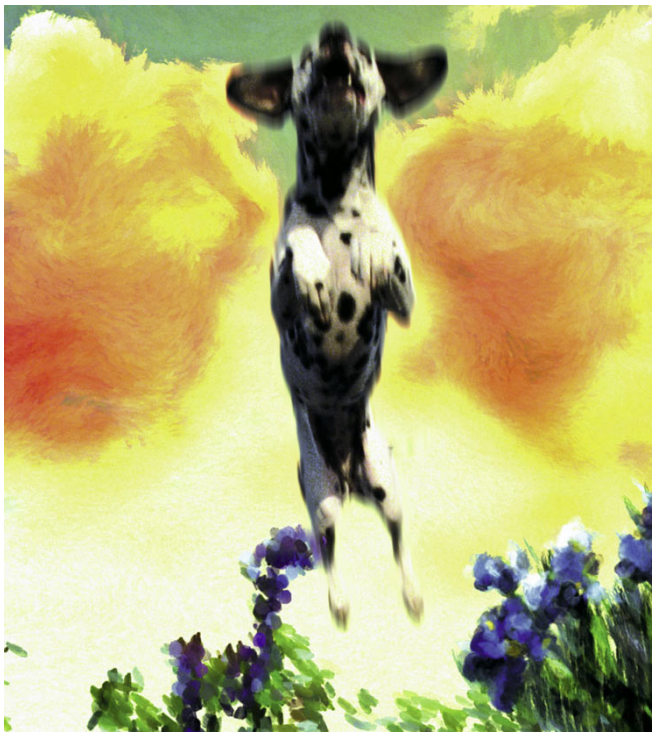
Once assembled, the team began researching painters and 19th-century fine art traditions in order to more fully define the look of the Painted World. “‘The obscuration of truth’ was a phrase that emerged from our studies,” remarked Hynek. “You see the rays of the sun in frame, but not the sun itself, as it is always behind clouds or mountains. This was a key element of the 19th-century ‘mysterious luminescence’ approach to visualizing the Afterlife. The whole Painted World reflects this concept, as the nature of life after death is hidden from us. Vincent selected stained-glass colors because that also mirrors the notion– a kind of light that conceals its source.” An invaluable information source was Stephen Hannock, a painter who works in the style of the 19th-century Romantics. “Stephen was a big help in determining how to transfer the essence of traditional painting to moving pictures. Along with production designer Eugenio Zanetti, Stephen painted over frame blow-ups of Montana to provide a design model for our artists. Ultimately, so many people were involved with transforming this imagery that it became a kind of art direction barn-raising.”

Another key member of the effects team was Mass.Illusions art director Joshua Rosen. Having painted frescoes in Italy and having worked with graphics software, Rosen possessed a foot-in-both-worlds background that wielded a distinctive look for the Painted World– a look that met

the director's expectations, while remaining true to 19th-century traditions and spurring the Evolution of CG imagery. "In Europe I developed a tremendous amount of technical knowledge about how the Old Masters assembled their paintings," Rosen related. "I'd even grind my own pigment while creating copies of their works. Later, I worked with Softimage and high-end rendering programs, using both radiosity and ray-tracing software. My own personal goal was to bring traditional fine art together with the digital world; and that came to fruition on this show through a traditional method of painting in layers that we adapted for digital imaging. I began with a base underpainting, adding a series of layers, with the first being very thin and the last containing the most texture. Nearly all of our Painted World shots in the film were assembled in precisely the same manner, with dozens of brush stroke layers built up– via Motion Paint's particle system– followed by light washes, light beams and, finally, the most heavily textured brush strokes."

Proceeding from Ward's initial shot layouts, Rosen worked with compositors to determine a basic color grading for each shot. "Compositional elements were introduced to determine the position of the light and how shadows would fall," stated Rosen. "Then we'd go through the rest of the shot, defining and placing various colors. Mattes would be pulled, after which we could add 3-D elements or matte paintings. Some comps had 120 to 150 different layers. Each of these required review before it went atop the rest, so we had to render out each layer of particle-system brush strokes to make sure the shot would hold together. This became even more of a concern editorially, since we match-graded the whole shot to make sure it would cut within the sequence." Location plates, filmed throughout the day, were also tweaked to create the backlit 'magic hour' look Ward envisioned for Summerland.

Chris' passion for art and his fathomless love of his artist wife Annie lead him to conjure a paradise rendered in paint. Mass.Illusions created the effect by animating and compositing multiple layers of 2-D and 3-D paint strokes onto meticulously tracked live-action footage. Nineteenth-century artworks served as the primary reference for the Painted World.



Mass.Illusions' contributions would focus exclusively on the Painted World, but there were myriad other aspects of Heaven and Hell requiring visual effects. "More than 300 effects shots were produced for this show," Ellen Somers stated, "although only about 240 ended up in the final film. As the work grew, we found ourselves having to split out certain shots within sequences and move them around. Managing these moves and coordinating between firms turned into quite the chess game." While the Painted World remained

principally the province of Mass.Illusions, some elements for the sequence were created by Digital Domain. Additionally, a number of the shots were composited by POP Film, which, together with POP Animation, joined the project in April 1997.

Physical interaction between the live-action characters and the Painted World was achieved by automating the digital paint strokes to move in concert with practical scene elements.

Visual effects supervisor Stuart Robertson and a number of POP artists visited the sets being built on the Treasure Island stages to get a better handle on the artistic concepts, availing themselves of Ward's enormous art reference collection in the process. "Vincent uses tearsheets like you wouldn't believe," remarked POP CG producer Cheryl Bainum. "He had a 120-page folder containing nothing but sky images. He wanted one piece of this sky, a cloud from another– then he'd reference a third piece to show how these elements could be blended."

Early moments in the film– directly following Chris' death– find the character dazedly wandering the earth, witnessing his own funeral and Annie's initially stoic response to his demise. Joining Chris is Albert (Cuba Gooding, Jr.) who first appears as a shimmering out-of-focus presence, and ultimately becomes his Afterlife tour guide. The illusory spirit was created by Digital Domain. "The production wanted something unique for the Albert-blur effect," stated Digital Domain visual effects supervisor Kevin Mack. "Claas Henke, Carey Villegas, Craig Halperin and I designed a watercolor-like painterly effect using image-warping and distortion, then added this ghostly trail– a temporal effect to suggest he is out of phase with respect to Chris. Different parts of his figure go in and out of focus at separate times, with some portions blurring more than others and his form becoming partly transparent in some spots. This made for a lot of articulated roto; and since there wasn't much in the way of clean plates, we did a lot of reconciliation." Custom software was written to create a blurring gradient across Albert's form, with digital noise being added to color the image. The heavy-duty image processing effort was accomplished using Digital Domain's proprietary Nuke software, while final compositing was done on an Inferno.

In his own version of Paradise, Chris suddenly realizes he is occupying the exact physical space that had held a single blurred human figure in one of Annie's paintings. The painting's principal element, however, is a distinctively gnarled tree– a mirror image of artist Casper David Friedrich's "Tree With Crows." A full-size prop tree was constructed and trucked to Montana, then photographed with a dramatic helicopter pullback. Although initially intended for only minimal enhancement, the Friedrich Tree shot was transformed considerably before being finaled, first with a matte painting by Syd Dutton of Illusion Arts, then through considerable CGI work that added beautiful 'obscuration of truth' light beams. Mike Schmitt's Giant Killer Robots team added these– along with waterfalls and cloud effects– and together with Mobility's John Volny, contributed to the reconstruction of plate elements.

In addition to their aesthetic impact, the atmospheric backgrounds also served to convey story points. Karen Ansel worked with Pierre Jasmin and Pete Litwinowicz to develop a swirling sky effect that revealed the degree to which Chris' emotional state impacted Summerland's appearance. "Nick Brooks, Joshua Rosen and I would review the live-action," said Ansel, "then consider the desired emotional arc. Detail was added to direct attention to desired areas of the frame. But since the qualities of this Painted World did not apply to the actors, it was a fine

balance to paint the scene while grading Robin and the others to pull them within the artist's palette."

Chris and his long-dead dog Katie– who leaps right out of a painted cloudscape to land in the stunned man's lap– brush up against foliage while proceeding further into the magical environment, inadvertently picking up bits of paint as they go. Spline-constrained skeleton forms representing the geometry of paint strokes were placed on scene objects prior to tracking, with full renderings of the desired scanned-in paint strokes added afterward. The numerous brush strokes scanned for use in Motion Paint had been taken from real oil paintings and represented the styles of many different artists. But it was the animation of those strokes that truly brought the style of the Old Masters to life. "The strokes came to life and dissipated in different ways," remarked Scott Gordon. "Usually they just faded on and off. But when there were occlusion issues and we had to see behind a plant or flower blowing in the wind, smaller paint strokes were created– ones that exhibited an organic kind of growth as the reveal continued. So we alternated between the fading and growing approaches, depending on the elements and reveals in each shot. These choices breathed life into many of the landscape paintings."

Demonstrating a freedom from physical laws that exists in the Afterlife, Albert playfully walks on water, entreating Chris to join him. On set, Cuba Gooding was photographed walking on a platform that was barely submerged in a shallow tank. The actor's image was then isolated and matted into a digital waterscape.

Chris attempts to follow– but unconvinced of his physics-defying abilities, he sinks into the lake.

Some shots tracking with Chris as he descends from a hilltop toward a pool of goo– a kind of psychic quicksand indicating that he does not know how to control this environment– were sufficiently complex to require even more finessing than the stroke-growing process afforded. “One technical dilemma that came about from using a moving camera in the Painted World was figuring out how to reveal new paint strokes entering frame during a pan,” Gordon noted. “The strokes going off-screen just disappeared, but the new ones had to be introduced in a way that did not read like big planks of paint popping on. We would determine where paint should enter onto the screen, then let Pierre Jasmin and Peter Litwinowicz deal with it. They created some unique stroke dynamics– a time-release, feathered kind of temporal reveal that had its own sense of inertia, apart from the actual motion extracted from the plate.”

Spotting a colorless bird fixed in the sky, Chris tests his nascent powers by willing it to fly and transforming it into a purple and turquoise vision. Digital Domain executed the animation of the fanciful bird, while Mass.Illusions realized the painted effect and composited the shot.

Tracking closely past a big tree during the descent, the camera reveals a smaller one in the distance. “Because this reveal was very quick,” noted Gordon, “I set up the particle system to switch on almost immediately, simultaneous with the move. It wound up looking as if someone was painting this tree right before your eyes, adding strokes at super-speed. When it came up in dailies, my first reaction to this obvious mistake was, ‘I’ll fix it.’ But Vincent loved the magical quality, so it stayed in. I’m a big fan of these happy accidents– and more than a few of them took place on this show.”

Gordon’s shots featuring Chris entering the pool of goo had to cut with already completed shots both preceding and following it– specifically shots introducing Katie, in a sequence supervised by Peter Travers. “Pete had established a look during the first shots with the dog,” Gordon explained, “and then there were other shots of Chris already in the pool, looking out across a lake at a beautiful cottage. It was up to us to create a look that bridged those shots, utilizing different compositing techniques to stack the brush strokes up and put them together in a way that was like going from one painter to another. We worked our transition around a horseshoe-shaped group of vegetation, going from one kind of Painted World to another during this one continuous moving-camera shot.”

Foreground flowers positioned in front of the pool were generated by VPLA, since the action– Chris snowplowing through the flowers before plunging into the goo– would require considerable interaction between Robin Williams and the CG elements. “This was the only time you saw liquid paint as opposed to brush strokes,” stated Gordon. “It was set up with closeups of his footsteps– and the dog’s paw prints– as Chris comes down the hill. As he raises his foot,

primary colors are revealed and we see that he's stepping in liquid paint– though on location it was really just mud. When Chris enters the pool of goo we're tracking both the reveal caused by his immersion in this viscous stuff and the liquid's naturally occurring movement throughout the reveal. We kept the area of the pool that Chris' entry affects well clear of particle-system paint strokes. We could have just rotoed a matte; but approaching it more scientifically gave the character's immersion a more appropriate look." A physical pool of liquid had been built on set, though colored streaks and swirls were added in post while relighting the environment to golden-hour luminescence. Footpaths were changed and flowers multiplied, and moss was added to a big rock at the center of the pool. In the sections of the goo pool where it was possible to get away with simple paint strokes, Motion Paint was used, while 3-D liquid paint elements were again created using VPLA.

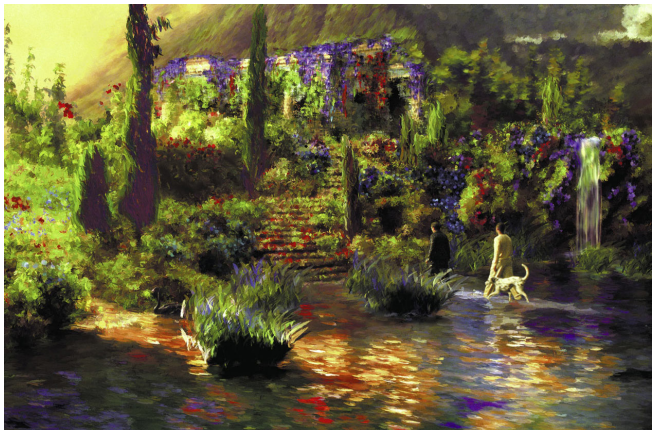
Albert appears to Chris once again, and explains the nature of these surroundings to him. Since the Afterlife is a product of Chris' imagination, Summerland is an utterly malleable environment. This revelation prompts a query from Chris about a painted bird suspended in the air overhead, seemingly frozen in mid-flight. A cross between a heron, a peacock and bird of paradise, the fanciful bird was built and animated at Digital Domain by Daniel Loeb, Bernd Angerer and Vernon Wilbert, using Softimage and Alias, and painted by Martha Snow Mack.

Following Albert's urging, Chris brings the bird to life with his mind, playfully transforming it to a vibrant turquoise color. Then Albert, who can also influence the environment, wills the bird to splatter Chris with a gooey painted dropping. The Digital Domain bird elements went to Mass.Illusions, where Cineon was used to composite them into a series of shots that established the proximity of the goo pool to a beautiful painted lake. "Unfortunately," observed Scott Gordon, "the water plate used for a bird's-eye view of Chris was lit flatly, and Machine Vision couldn't pick out any detail on the water; so our processes inadvertently created this sloshing liquid that looked like one of those wave toys you see on people's desks. But, again, it stayed because Vincent loved the look."

As they had with the pool of goo, Gordon and Ansel oversaw separate shots within the painted bird sequence, which concludes with Chris stepping out of the muck, only to plunge to the lake bottom while attempting to emulate the effortless walking on water demonstrated by his dog and Albert. Yet another group of artists– alternately supervised by Nick Brooks, Ansel or Gordon– handled the water-walking effects, for which live-action had been shot on stage at Treasure Island with the performers working in inch-deep water before a greenscreen. Wide shots featured highly abstract, stylized, Monet-cum-Van Gogh brush strokes that measured nearly as long as the human characters were tall.

Chris eventually surfaces and, with his dog and spirit guide, approaches a house– the Painted World's version of his and Annie's lakeside dream cottage, in which they had hoped to live together in their golden years. The cottage had been built on a greenscreen stage at Treasure Island, but there remained the matter of nestling it into the wilds of Glacier Park. To that end, Joel Hynek spent hours airborne above Montana in search of a site that would define the geography of Annie's painting with respect to the actual location.

While inside the dream cottage, Albert introduces Chris to the true Summerland Paradise, pushing a section of Painted World wall away to reveal a gloriously unpainted world vista. Though the idea of Summerland as a wholly natural environment was considered, the final vision employed a large measure of matte-painted imagery, produced by POP Animation. “Vincent wanted a landscape that lay somewhere between the Painted World and the real one,” POP senior matte artist Deak Ferrand explained. “He thought the original Montana plate was beautiful, but he knew there were elements that could be improved. In the end he decided to have us go crazy with it. After the mountains and sky were replaced, a big panning move was added, so we went to 3K for the painting. Then Vincent decided he did not like pine trees, so those all went out. The idea kept shifting as we added new elements, populating the hillsides with statuary, until we had painted out nearly everything in the plate except for the water.”



Accompanied by Albert and Katie, Chris approaches the Painted World version of the dream cottage where he and Annie had imagined themselves retiring and growing old together. Before the Painted World could be realized, Mass.Illusions had to develop new image-based paint animation software and tracking techniques.

The background colors also changed to a Maxfield Parrish-like palette– though legal ramifications kept the actual style of painting far removed from that artist’s distinctive look. To ensure that there was a unified approach to color throughout the Painted World, POP digital optical supervisor Greg Kimble color-corrected nineteen shots requiring compositing of live-action with Mass.Illusions’ transformed environments. Digital effects supervisor Ken Littleton and digital compositor John Rauh handled the Summerland reveal, which combined Deak Ferrand’s painting with bluescreen live-action.

Mass.Illusions visual effects supervisor Joel Hynek oversaw the creation of the Painted World and was largely responsible for developing an approach to the unusual effects assignment, while art director Josh Rosen lent an artistic eye to ensure consistency of the concept was maintained throughout the film. Rosen and Hynek review a shot in progress.

Chris catches a fleeting vision of his wife and sets out after the lovely illusion, first falling harmlessly off a towering cliff and then speeding through a poppy field in pursuit. To provide imagery for the plummeting figure, stuntman Jake Lombard made twenty-two leaps off 3200-foot Angel Falls in Venezuela, deploying a concealed parachute at the last possible moment. Digital Domain effected parachute removals from the footage, then enhanced the sequence by creating a CG Robin Williams as his plunge takes him through the waterfall. “We performed a mattress removal for Robin’s landing as he flops down in a poppy field,” Kevin Mack elaborated. “The poppy shots were done on stage with some foreground vegetation, so we had to roto those

flowers, then do a lot of poppy multiplication to fill out the shot. The backgrounds– skies and mountains, plus an additional field of poppies– were created by matte artist Shannan Burkley who, along with Paolo De Guzman, salvaged a lot of the Montana plates."

Still locked in the physical world, Annie attempts to finish a tree painting she had originally begun as a gift for Chris. Concurrent with her completion of the piece, the Autumn Tree– abloom with lavender flowers– springs into being in her husband's Afterlife environment. "Chris sees it and realizes that Annie has finished the painting," Mack commented. "But then Annie, very despondent, destroys her painting; and the color from the flowers drains off, leaving just the bare underpinning of a skeletal tree." Chris' emotional discord at witnessing this manifests itself in the Summerland sky, as a powerful wind comes through to blow all the dead flowers off the tree. "Since there were a number of shots featuring this 3-D tree, and it had thousands of branches, modeling it would have become an enormous project. So instead, we used L-systems."

Named for botanist Aristid Lindenmayer, L-systems define a formal grammar for describing plant development, as well as classifying all plants and every conceivable branching structure. "After computer graphics evolved," Mack stated, "some of Lindenmayer's students realized the system could be used to draw pictures of the plants. Being a formal scientist, Lindenmayer didn't think much of this development, but it has since taken off. L-systems have seen some limited use in the entertainment arena; but to the best of my knowledge this is the first feature to employ the process so prominently– and this was certainly the most complex L-systems tree ever grown for a film. The rules can be as implicit or as explicit as desired; so you can explicitly direct L-systems to grow a branch at a particular point, in essence art-directing the growth without resorting to modeling. They grow a certain number of branches, then instruct leaves to form. It's all very procedural and rule-based, so a whole complex plant can be defined with just a few lines of rules." The complexity of the Autumn Tree required a dozen pages of growth instruction. "To accommodate any changes, we simply modified the genome of the tree and grew it again– though the geometry was so complex we had to wait overnight to see the next iteration completed."

The tree's flowers were also grown using L-systems; but in order to blow them off, particle system flowers were exposed to an elaborate turbulence simulation to create credible multidirectional movement and drift, as well as collision with the tree and terrain. "There were also some pretty elaborate lattice deformations of the tree itself to make the branches sway," Mack noted. "David Prescott was mainly responsible for growing the tree, while Matthew Butler handled flowers and the physical simulation with the flowers blowing off. Mapping texture maps to five hundred thousand individual flowers with translucency, motion blur and shadowing was accomplished by Darin Grant, using RenderMan. These guys really embraced the L-systems approach, taking it much further than I would have thought possible." For backgrounds, Martha Mack created large matte paintings that matched the semi-painterly Summerland look and could be used for different angles in the sequence. The roiling clouds reflecting Chris' unhappiness were also painted by Mack– though a number of image-warping techniques and comping tricks, devised by compositors Darren Poe and Craig Halperin, were employed to

incorporate atmospheric changes, including cloud movement and fluctuating light effects on the sky and landscape.

Annie finds it more and more difficult to go on in the wake of her husband's death. Chris, now accompanied by the mysterious Leona (Rosalind Chao), finds himself in Consciousness City– the 'common room' area of the Afterlife, perceived by all in the same way. Penny-farthing bicycles and parasols were featured in the sets to evoke 19th-century resonances, while the architecture was designed to suggest a timeless quality spanning many periods. Angelic figures flying overhead were depicted by women dressed in flowing white robes, suspended on wires and shot greenscreen.

For a twenty-two-second reveal of Consciousness City, Deak Ferrand created an elaborate, sparkling painted environment. "Vincent wanted the classical view of Heaven you'd find in a John Martin painting," recalled POP matte painting supervisor Rocco Gioffre, "though Deak was also influenced by Gustave Doré's biblical etchings. In addition to brilliantly lit heavenly clouds, there was an enormous waterfall at the bottom of the frame which was all CG. It was one of the few shots in the whole show that employed motion control, so Deak had to match his painting to the live-action stage moves, which were shot on a tremendous set built at Treasure Island."

Many cuts in the twenty-shot sequence featured a forty-by-eighty-foot staircase on which Robin Williams, Rosalind Chao and numerous extras were photographed. 2-D digital extensions were required to increase the set piece's on-screen size by a factor of six. The alignment of the extensions was problematic, as the live-action plate included a huge motion-control camera move that descended, then tilted up to reveal the city and the sky. "The perspective changed so severely during the camera move that we had to warp our stairs to match perfectly with the live-action," commented Deak Ferrand. "The other problem with this plate was that the staircase had only been lit in areas where the actors were standing. The set was built all the way up to the facility's ceiling, so light falloff on the rest of the stairs was unavoidable. We had to cut a traveling matte close to the actors and roto them, then replace the lit area of the stairs and use that as a basis for the digital extension." Due to the expansive camera move, a huge matte painting was needed. "To align the 2-D background with the foreground elements we had to use a special shader to render the painting as a warped texture– a grid on the inner surface of a cylinder, like a rolled-up map. It was like painting in anamorphic, since the background was essentially being created as a deformed and distorted image before being ported to Softimage." Digital compositor Brandon McNaughton, along with Ken and Lawrence Littleton, composited the elements against Ferrand's paintings. Ferrand also created the water beneath the staircase digitally, using a 4D Vision Lumetools shader.

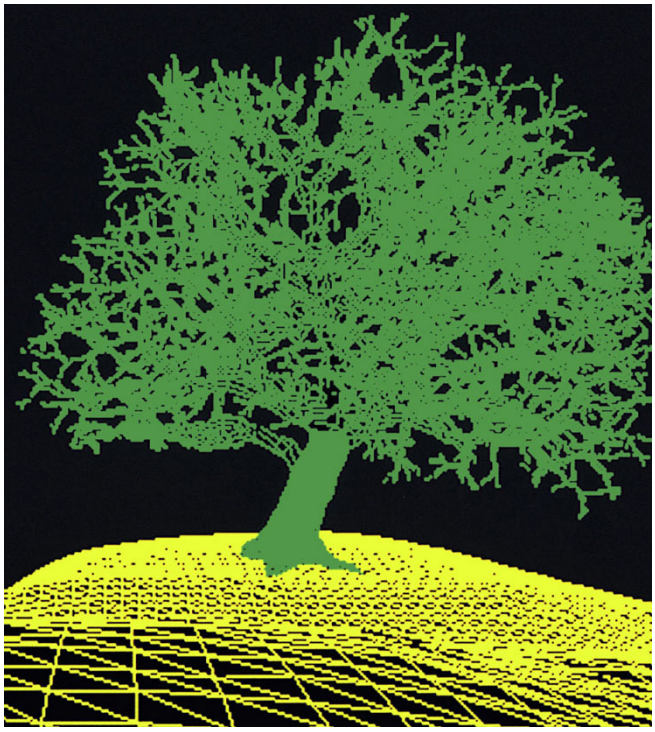
To avoid a rendering bottleneck, a particle system approach was employed for depicting background figures. "Starting with several greenscreen figures shot dead-on," Cheryl Bainum explained, "our particle system took each sequence of moving figures and 'instanced' them as particles. This allowed us to automatically size and scale each particle person relative to the portion of staircase extension they were assigned to occupy. We could retain the original color schemes for these particle-system characters or change them from light blue to orange– whatever worked best for each shot's palette. After the designated colors were assigned, the system performed all necessary calculations. It was a big help to us, since it meant not having

to hand-animate a bunch of CG people.” The Consciousness City shots were ultimately made up of many layers, consisting of live-action, CG people, painted city and atmospheric elements. Heat waves rising off the city were added as a final layer in the precomp to suggest the look of a mirage, as mandated by Vincent Ward.

The look of the film’s environments ranged from extremely stylized to fairly realistic, depending on Chris’ emotional state. For a wide shot of the dream cottage in a less stylized form, Digital Domain composited plates filmed in Glacier National Park with a bluescreen stage element of a practical cottage set.

Greenscreen imagery of the actors water-walking on a submerged platform was also composited into the shot.

The soul-mate connection between Annie and Chris is evidenced when elements of a landscape Annie is painting in the living world– specifically, a tree abloom with lavender flowers– appear in Chris' Afterlife environs.



At Digital Domain, the tree and rolling foreground were generated in wire-frame form and then rendered to allow for computer animation of the tree losing its petals and dying when the grieving Annie destroys her painting.

Chris sets sail with Leona, passing a beautiful Bridge City structure resembling the marionette stage that once occupied a favored spot in his daughter's room– a subtle indicator that more than just Chris' psyche is influencing this environment. Chris soon realizes that Leona is actually his daughter Marie, now free to inhabit a form of her own choosing. Rocco Gioffre first created Bridge City in Photoshop, working from designs provided by the production. "Those designs indicated a preference for a nice sunset look," noted Gioffre. "Yannick Dusseault used Softimage to transform the image into 3-D, mapping portions of the painting onto grids that were later warped, then adding 3-D islands and water generated using Lumetools."

To complete the shot, the CG tree was matted into a matte-painted background featuring a stormy sky and shifting clouds.

In the land of the living, Annie, having realized the best part of her life is gone forever, decides to take her own life. When Chris learns of her suicide, his rage literally darkens the skies. Created from a collage of stock-footage elements contributed by Australian cinematographer Simon Carroll, POP digital compositors David Crawford and Brian Hanable utilized Inferno to handle the compositing. Informed that all suicides must take up permanent residence in Hell, Chris decides to rescue Annie from eternal despair. With Albert guiding him, Chris ventures to a surreal library where skyscraper-size bookcases rise out of the river. Here, he recruits a Tracker (Max Von Sydow) who will take him into Hell in search of Annie.

To shoot the scene, a shallow tank was built on stage, along with the library's multistory front wall– which went all the way up to the top of the Treasure Island hangar– plus parts of the two adjoining ramparts. In addition, a portico was carved out of the wall to allow the boat carrying Chris and Albert entry into the library. Since Eugenio Zanetti's set for the library, while tremendous, still did not capture the scale Ward desired, POP was called upon to extend the set digitally. "That set was amazing," stated Rocco Gioffre, "but we needed to increase its size by a factor of about four to really create the desired scale."

Tracking the CG set extensions to the set would prove to be one of the shot's biggest challenges. "Vincent chose to use a Technocrane for the reveal of this vast interior," said POP executive producer Andrea D'Amico. "Since this was not a motion control crane, there was a huge move and all kinds of bumps and natural motions that our CG extension would need to track perfectly. The floor of this 200-square-foot set was a tank filled with water, so we devised a method for obtaining tracking data that involved installing our own markers– which made for an entertaining evening in wetsuits. In addition to our own tracking software we used 3D-Equalizer, which made this very difficult tracking job possible. The CG set and water were

created by Yannick Dusseault, with tracking by Miles Essmiller.” Not only could 3D-Equalizer calculate camera movement and lens distortion, but it could also develop range data without resorting to traditional survey techniques– though such information, when available, did serve to speed the tracking process.

Another issue concerned the wire-rigged extras suspended in front of the library wall throughout the crane move. “The horizontal shelves and the books themselves made for a busy background that, coupled with the fact that the shot had been done wild with no blank plate, prevented wire removal,” Rocco Gioffre explained. “So, much to Eugenio Zanetti’s displeasure, we ended up having to throw away his stage set. But Yannick Dusseault was able to use Softimage to build a beautiful 3-D replica of the library wall that proved indistinguishable from the real thing.” Dusseault again utilized Lumetools to digitally emulate the look of the tank water, with the results blended together by POPdigital compositor Jacques Levesque. Numerous drifting CG people arrayed toward the rear of the library were hand-animated, with each figure requiring depth-fading and atmospheric attenuation. The shot’s final layers featured David Crawford’s additional groupings of greenscreened people composited into both the midground and foreground.

In the course of discovering his surroundings, Chris is introduced to Consciousness City, the common vision of all who have reached this new dimension. A giant staircase set constructed on stage was extended and enhanced with a 2-D matte painting executed by POP senior matte artist Deak Ferrand to suggest a classical depiction of Heaven. Added elements included particle-system background characters and flying angelic figures, achieved by filming white-robed actors suspended in front of a greenscreen.

Ferrand and matte painting supervisor Rocco Gioffre review one of their shots.

With the Tracker now aboard their tiny sailboat, Chris and Albert put out to sea. In a series of shots that alternated between greenscreen stage footage and real open-sea photography, the adventurers are glimpsed beneath time-lapse skies– filmed by Simon Carroll– as they struggle to remain afloat in a literal sea of despair. The situation becomes even more threatening when they are overcome by a huge tidal wave– created by Digital Domain. “It was a wall of water,” Kevin Mack explained, “with all these human bodies flying out of it as lightning flashes in the air. Claas Henke did the waves using production water plates, combined with crashing wave elements shot by Yuri Farrant in Hawaii. Shot in daylight, all of the elements had to be graded for night. Stock lightning, time-lapse storm clouds, rain and atmosphere were added, plus interactive light on the water, using Inferno.” Christopher

Roda, Keith Huggins and Vernon Wilbert handled the flying human bodies in Softimage, textured with maps painted by Martha Mack.

Reminiscent of painter Théodore Géricault's "Raft of the Medusa," shots of the boat being capsized in the storm required countless damned souls– dubbed Hellions by the production. "Vincent had Jacques Levesque duplicate the Hellions to fill out the number of swimmers in the water," Gioffre explained. "Jacques also dealt with the boat as it gets pulled over– another shot achieved without motion control– and his ability to take those elements and track them back in was just phenomenal." POP technical director Barry Robertson's proprietary software was utilized to create rain and smoke for the scene, while seamless hookups between Areté and live-action water were provided courtesy of CG artist Seth Lippman.

The intrepid voyagers wash ashore, soon thereafter encountering a vast wasteland of sunken ships rotting at the bottom of a dried-up ocean. Among them is a burning aircraft carrier, the Cerberus, which is inhabited by thousands of raging Hellions and acts as a gateway to Hell itself. For the live-action shoot, production dressed and set ablaze U.S.S. Hornet, a real carrier moored at nearby Mare Island Naval Shipyard. In postproduction, the balloon-suspended lights illuminating the scene were extracted digitally by CIS Hollywood.

But even after capturing extensive location footage– with hordes of extras dressed as damned souls aboard the carrier– a miniature duplicate of the vessel, along with a siege tower and several other model ships, was required to complete the bleak vista. Cinema Production Services, which had been approached initially to provide miniatures for a number of heavenly vistas as well as hellish digs, wound up with two miniature projects: the nether region's upside-down cathedral and this graveyard of lost ships. "It was probably six months between our getting the job and the time we actually began work on it," recalled CPS owner Michael Joyce. "When the go-ahead finally came, the production had already established its base of operations up north; so I wound up making a lot of trips up there to get the design and coloration right for both models."

The ship graveyard was a wedge-shaped tabletop miniature that measured ninety feet wide at the rear, sixty feet deep and sixty feet wide at the front. Various vessels were built at different scales, permitting a slight forcing of the perspective. The 1/48-scaled aircraft carrier was heavily detailed and measured approximately eighteen feet in length, while the other ships were simpler background pieces built at 1/48-, 1/72- and 1/96-scale. "We redressed some boats to look like different craft for other shots," Joyce observed. "We made one of the background boats over as an old paddle-wheel ship that is seen in the foreground when they first come over the hill and happen upon the graveyard. The paddle wheel actually moved, so we set that up to be actuated via stepper motor." Hired to shoot the miniature sequences, effects cinematographer Garry Waller employed a motion control system provided by General Lift. The ship graveyard miniature incorporated greenscreened live-action of the principals that had to be tracked in for the duration of the five-hundred-frame shot, which featured a sweeping move around the aircraft carrier. To complete the illusion, extras and full-sized flames seen on the real carrier were extracted from the plate and composited onto the decks of the ship miniature.

At POP, particle animation was used to achieve a sandstorm effect, amplified by black smoke sweeping across the landscape kicking up dust. “We looked at real footage of the Gulf War for reference in creating these ‘Kuwait skies,’” said Andrea D’Amico. “They were a combination of Rocco Gioffre’s painting, Barry Robertson’s smoke and some stock footage. The sky was supposed to have a blood-red, burning hellish look, but it couldn’t be too luminous or the dark feeling would have been lost. A lot of selective color correction went into maintaining the narrow palette desired. At the end, Vincent had us add a small cyan-colored streak in the sky that really made the shot, giving it a sense of beauty that seemed to transcend Hell.”

MastersFX was chosen to create makeup effects for the resident Hellions. “Vincent and I met over beers one Saturday afternoon to go over his reference material,” recounted company president Todd Masters. “It was mostly from the Renaissance, though there were surrealists, as well, including Dali.” Inspired by the reference material, Masters produced reams of computer generated makeup drawings, from which Ward selected his preferred designs. Though most of the Hellions would be background figures, both Masters and Ward wanted their facial features to register strongly. “We settled on a stylistic approach we called ‘billboard art’ since it was akin to seeing something on the highway– a graphic concept that had to register immediately. These were the kinds of apparitions that worked best when their features were just glimpsed briefly out of the corner of the eye. Details would not necessarily register in the audience’s brain, but the loose visceral stuff they’d get from that quick glimpse was enough to permit them to connect everything else up for themselves.”

Instead of representing all of the Hellion facial markings as bruises or wounds, Masters opted for a more impressionistic approach, with facial pieces manufactured as components, allowing for the mixing and matching of strange eyes and weird mouths for the multitude of performers. “There were thousands of applications,” Masters commented. “Every single day we did between three hundred and five hundred extras, all requiring special makeup. Hell was truly ominous-looking, even before any visual effects had been added.”

With Chris distracted by a memory of his dead son– whom he comes to realize has taken the form of Albert– the Tracker loses his fix on Annie. Following the Tracker’s advice, Chris leaves Albert behind to embark on the next leg of his odyssey, in course arriving at a sea of imprisoned, upturned faces that seems to reach to the horizon. The sea of faces was crafted by plaster foreman Robert Guess as a large platform on stage, with countless static faces sculpted into the surface. To bring this eerie setting to life, MastersFX created prosthetic appliances that matched the pasty tones of the sculpted faces, applying them to actors who were interspersed and stationed beneath the platform with their heads extending up through it.

Chris, mistakenly thinking he sees Annie’s visage among the faces, races forward and crashes through the surface, plunging into Hell. Connective material linking the sea of faces scene with Chris’ entry into Hell was conspicuously absent in early edits of the movie, creating an inadvertent jump-cut quality to Chris’ odyssey. As a result, a new sixteen-second bridging sequence was conceived and executed at POP, where Softimage was used to produce a 2-D animatic. “It was based on Doré to some degree,” said Deak Ferrand, “and also on some reference photographs, provided by Vincent, of a mine in South America with thousands of

people clinging to rock walls. On the basis of our pre-viz, approval for funding this transition was granted. The whole thing was CG and matte paintings, with millions of moving CG people on rock walls. The background figures were more of our particle people, with the closer silhouetted figures– the ones climbing CG rocks– all hand-animated 3-D."

Upon learning of Annie's suicide, which has doomed her to Hell, Chris determines to find her through a Tracker, whom he meets within a surreal library.

Production designer Eugenio Zanetti built a massive library set, complete with water tank, that filled an empty aircraft hangar in San Francisco. The library was then increased to four times its physical size via digital set extensions rendered at POP.

Chris and the Tracker, en route by boat to find Annie, are tested by a savage storm at sea. Digital Domain created a huge tidal wave by combining water plates and crashing wave elements. Stock lightning, rain and cloud elements were added to intensify the storm.

The voyagers are washed up onto a dried ocean bottom covered with wrecked ships, including a burning aircraft carrier that serves as the gateway to Hell. Live-action scenes featuring hordes of extras– in hellish makeup by MastersFX– were shot on a real carrier moored at Mare Island Naval Shipyard.

Hellions dislodged by Chris' plunge burst into flame as they drop– a particle animation effect done by Ann Monn on Inferno. At the tail end of the shot, the tops of the cathedral pillars come into view at the bottom of the frame, linking into subsequent shots of Chris falling through to splash-down within the upside-down cathedral– represented by a Cinema Production Services model. "At first we thought there would be a wipe to the model cathedral," Rocco Gioffre noted, "but instead Deak Ferrand put in CG pillars and color-corrected them to match the miniature, being careful to incorporate all of the nice light rays they had created while shooting on the model stage." A greenscreen Robin Williams element was incorporated into the cathedral miniature for his fall into water, which cut with a real immersion of the actor on set. "Following that nifty transition between motion-control miniature and live-action, there is a matte painting of Annie's home– the Hell House."

This footage was complemented with an even more expansive tabletop miniature, built by Cinema Production Services, that showcased a variety of rotting vessels. Painter Jeryd Pojawa adds finishing touches to a paddle-wheel ship model.

The Hell House– a reference to Richard Matheson's horror novel of the same name– had been built as a full-sized set at the Alameda Point Naval Air Station, but was also constructed in miniature, situated within the cathedral model. "We built detailed maquettes for use with a lipstick camera," Mike Joyce stated. "These helped us to figure out workable camera angles for seeing the house within the cathedral miniature. We took the video to the director and, after getting an okay, worked from there to construct the cathedral model. The base of our cathedral was all fiberglass, assembled from molds. The overall set was about twenty feet wide and maybe four times as long, with pillars that went up about thirty feet. We built the columns– all thirty of them– from wood and benderboard." Joyce and Stuart Robertson designed the shots so that the foreground columns could be repositioned forward and shot again, visually doubling the set's length. The pillars required labor-intensive scribing, as the model's scale– representing fifteen hundred feet in real life– rendered painted-on detail inadequate. Eugenio Zanetti visited the CPS shop to review the myriad textures and paint samples developed by Joyce's crew for the cathedral and its rubble-strewn pond of murky water.

Just a tiny portion of the miniature was used to represent the house in long shots, but that segment was an extremely detailed one. "We wound up pushing the scale of the house a bit," Joyce admitted. "It should have been about 1/48, but we went 1/36 to ensure that it would read better for the camera." Garry Waller again handled the miniature shoot for the upside-down cathedral, with POP Film compositing the various elements.

Searching for Annie, Chris and the Tracker descend into Hell, represented by an upside-down cathedral. The cathedral was constructed as a miniature by CPS, then extended with columns via a digital matte painting produced at POP by Deak Ferrand. Finally, greenscreen footage of Robin Williams and Max Von Sydow was incorporated into the scene.

To animate a sea of faces over which Chris must pass, an elevated platform was covered with sculpted plaster visages. Interspersed among them were live performers fitted with mix-and-match prosthetic appliances by makeup effects artist Todd Masters.

Warned that his very consciousness is at risk if he overstays his visit with Annie, Chris attempts, unsuccessfully, to rouse his wife from her eternal self-pitying reverie. Failing in his efforts, he elects to stay with his wife in Hell House rather than return to Paradise– a sacrificial act that finally triggers a response from Annie, who comes back to herself. Chris awakens to discover that he and Annie have been miraculously whisked back to Summerland, where they are reunited with their children. POP Film executed numerous composites for the family reunion, extracting the performers and compositing them into an even more idyllic backdrop.

Chris and Annie's reunion in paradise plays out after a long camera push-in on the dream cottage and its surroundings. For the continuous shot, matte artist Michael Lloyd created two digital matte paintings– enlivened with numerous moving elements– that were assembled and seamlessly joined by CIS Hollywood.

The movie's original scripted ending had Chris and Annie's consciousnesses entering the bodies of newborns– another pair of soul mates predestined to meet in adulthood and experience brief, bittersweet romance. But the ending tested poorly and was cut, leaving an abbreviated conclusion that lacked resonance. "As a result, production returned to the bay area to do some pickups in Marin at Phoenix Lake," Ellen Somers recalled. "The shots featured the whole reunited family dancing along the water. It was an approach to the material that wasn't as theologically heavy-handed and provided an opportunity to return to the visual glories of Summerland."

A sweeping push-in to the family dancing in front of Chris and Annie's dream cottage acted as a kind of bookend for the filmic Afterlife, working in tandem with the earlier Friedrich Tree pullback. The shot was the result of a joint effort involving CIS Hollywood and matte artist Michael Lloyd. "From a matte painting standpoint, it was nice to do something a little stylized," commented Lloyd, who co-supervised the matte work for the uniquely stylized Dick Tracy. "Since I've worked as a traditional artist, as well, it was nice to just see something other than pure realism being attempted. Since everything's already been done, it becomes a matter of doing the same things over again while viewing them in a different kind of light. That's what painting, filmmaking, storytelling and all forms of art are really about. Viewing these images after digital manipulation, you realize that they are the same bits and pieces of things seen elsewhere and previously– they're just not appearing the same exact way."

The reunion push-in, originally conceived as two shots with a cutaway bridging the moves, wound up being consolidated into one continuous shot when it was discovered that the two parts dovetailed perfectly. "I wound up using the foreground area featured in the Friedrich Tree helicopter pullback," stated Lloyd, "then redesigned other aspects of the shot, using that element and Syd Dutton's painting as inspiration." To maintain image resolution throughout the camera move, two separate paintings were required. "It was going to be composited at 4K, but I created my artwork at 8K. That allowed us to move in a good ways until the image started to drop out, then hook up to a second matching painting and keep moving in."

Lloyd’s paintings combined photographic nature elements with fully synthetic painted ones. “My shot departed from the Painted World look,” remarked Lloyd. “This was merely heightened realism, more stylized than any kind of imagery you’d get shooting a beautiful location from the air. There are about nine different waterfalls in the shot, some of them painted, others a product of live-action shot at Niagara Falls. Many location elements had been shot as tiles that I subsequently reworked. It’s kind of silly to paint a detailed natural landscape when there’s photographic reference available, so the work was principally manipulation of these preexisting tile elements. But even so, I doubt that there’s an ‘as is’ element surviving in the final comp; everything went through a number of alterations.”

At CIS Hollywood, under visual effects supervisor Ken Jones and executive producer C. Marie Davis, digital artists Gregory Oehler and Suzanne Mitus-Uribe composited Mike Lloyd’s digital matte paintings, adding a camera move and time extension to the push-in, then supplementing the shot with a variety of embellishments, including live-action elements that had to be tracked to accommodate zoom moves, along with flocks of CG geese. The resulting image evoked not only Casper David Friedrich, but captured the style of Hudson River School painters Thomas Cole and Albert Bierstadt as well, again reinforcing the obscuration-of-truth philosophy espoused by 19th-century artists and mandated by Ward.

Because issues still remain for Annie to work through, and Chris wants only to be with her, the two are returned to earth to live out their lives anew. The film concludes with them meeting as seven-year-olds, when their toy boats collide– an uncanny echo of their previous-life first meeting.

Vincent Ward’s vision of a love that transcends death had required the effects houses serving What Dreams May Come to create an astounding number of visual effects elements, with Mass.Illusions alone generating a quarter-million elements for the Painted World. But it was more the nature of those elements than their sheer quantity that proved most challenging and rewarding. “There’s an artist in each of us,” reflected Joel Hynek, “and the allure of this show was the opportunity it provided to indulge that personal artistic bent. Making the movie was a long, but pleasant and fulfilling journey, and served as a kind of culmination to the aspect of visual effects that combines– or reconciles– the technical with the aesthetic.”

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